

Satellites in Our Everyday World



North Carolina State University

Joseph Knight

What will we talk about?



- Fundamentals**
- Major R.S.**
Sensors
- Applications**

What is Remote Sensing?

The acquisition and measurement of data/information on some property or properties of a phenomenon, object, or material by a recording device not in physical contact with the feature under surveillance.

Usually refers to the use of airborne or satellite imagery.

Photogrammetry

Photogrammetry is the technique of obtaining reliable measurements of objects from their photographic images. The word Photogrammetry is derived from three Greek roots meaning “light-writing-measurement.”

Geographic Information System

An organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, and analyze various forms of geographically referenced information.

Terminology: Resolution

Spatial Resolution: the smallest object you can resolve on imagery

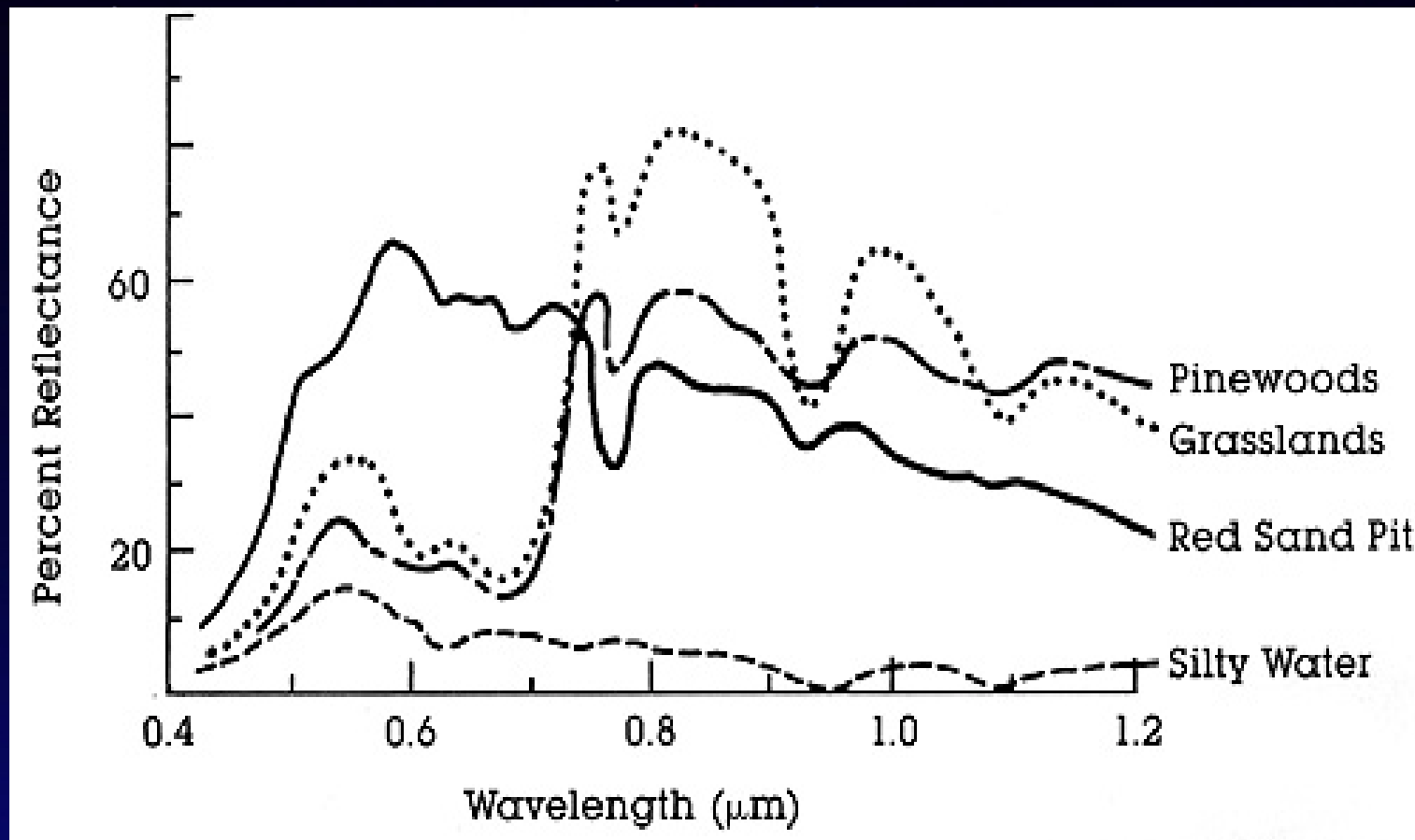
Spectral Resolution: the number and distribution of the bands in a sensor

Other resolution types: Temporal, Radiometric

Terminology: Signature

The characteristic spectral response of an object or an environmental association.

Spectral Signatures

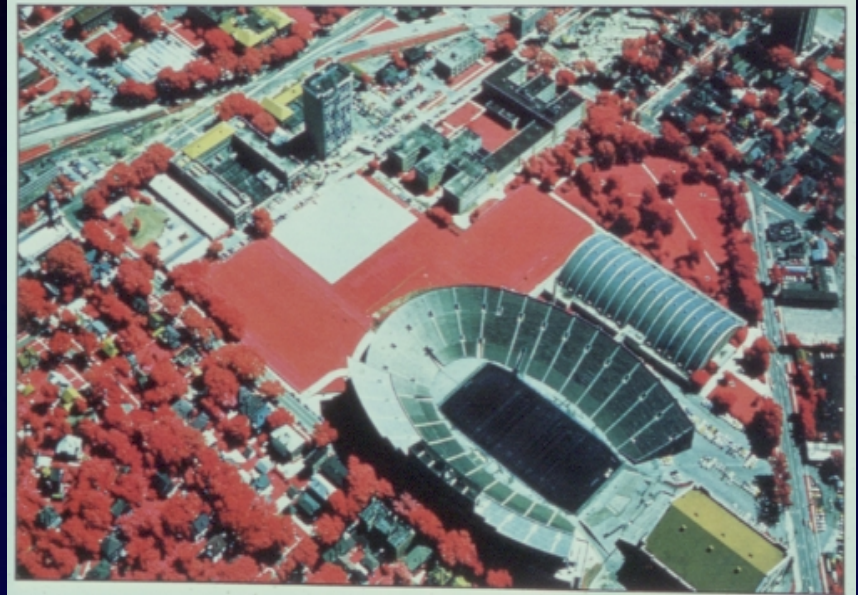






S. Khorram





MAJOR EARTH OBSERVING SENSORS

- GOES
- AVHRR
- Landsat
- SPOT
- NASA's Terra Satellite (ASTER, MODIS)
- Ikonos

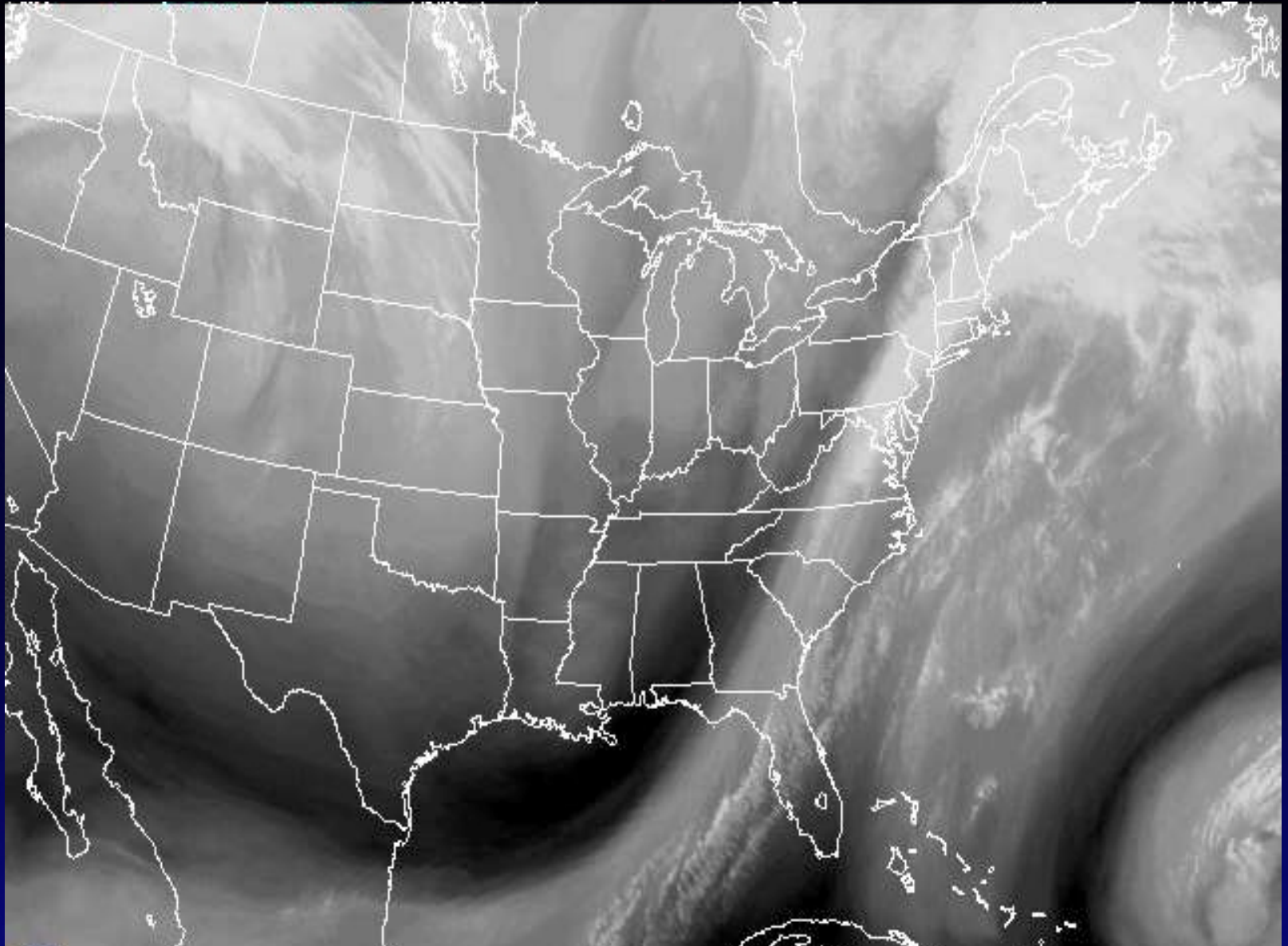
GOES

(Geostationary Operational Environmental Satellites)



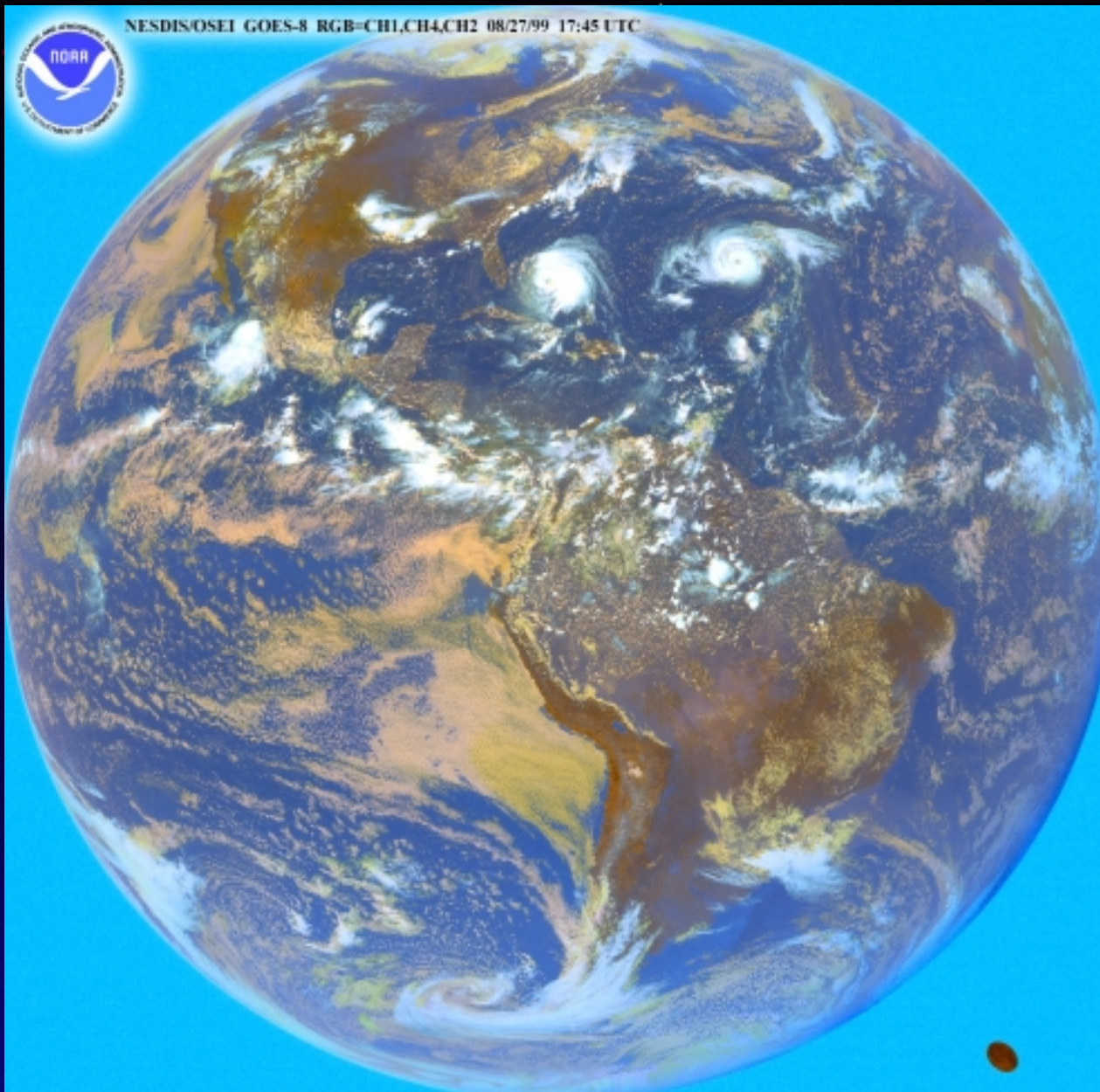
- The GOES series of satellites is the primary weather observation platform for the United States.
- Spatial Resolution: 1 and 4 km
- Spectral Resolution: 5 bands in the visible (1), reflected IR (2), and thermal IR (2)

GOES-8 Water Vapor Image (4/4/2000)



GOES-8

08/27/99



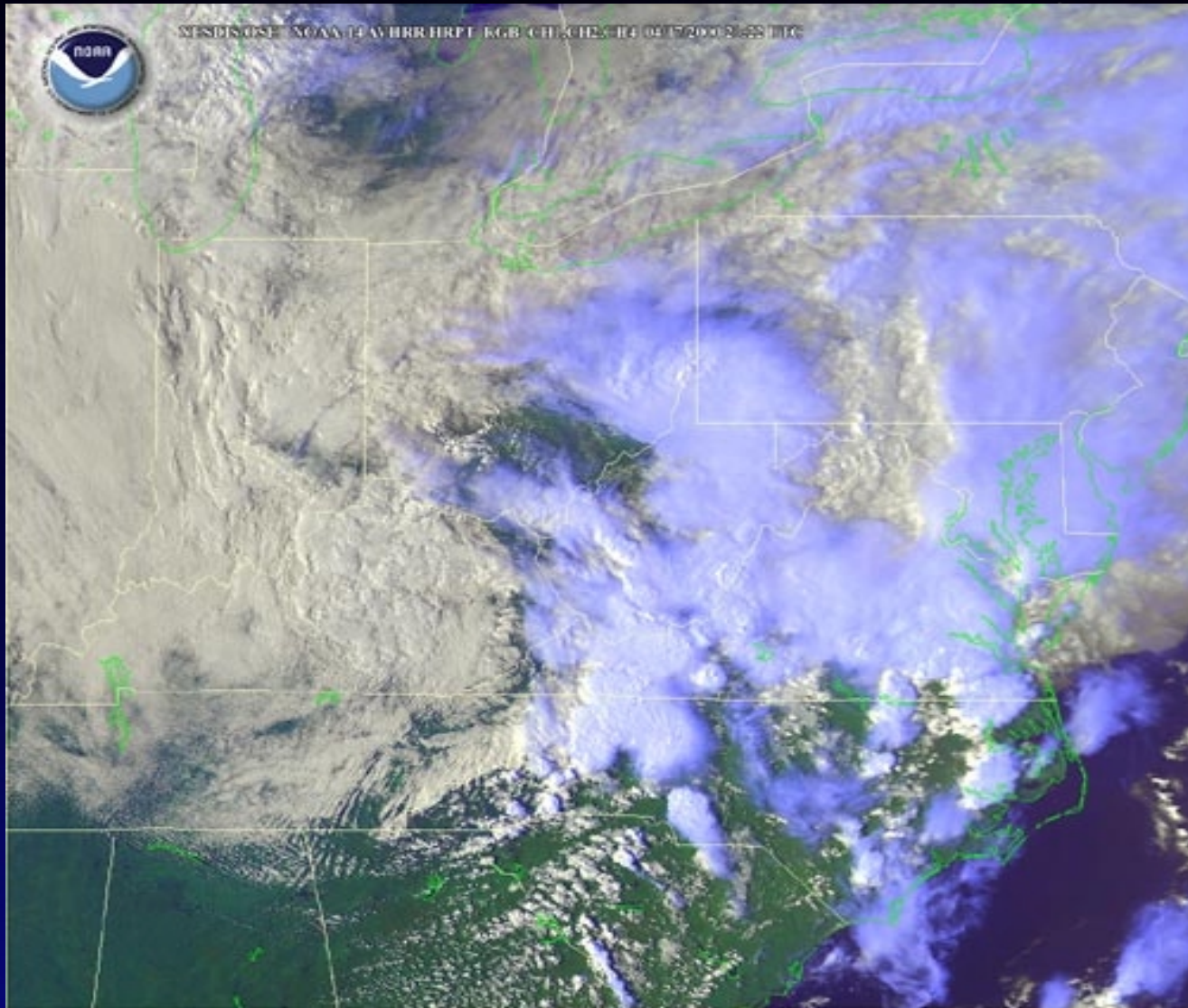
AVHRR

(Advanced Very High Resolution Radiometer)

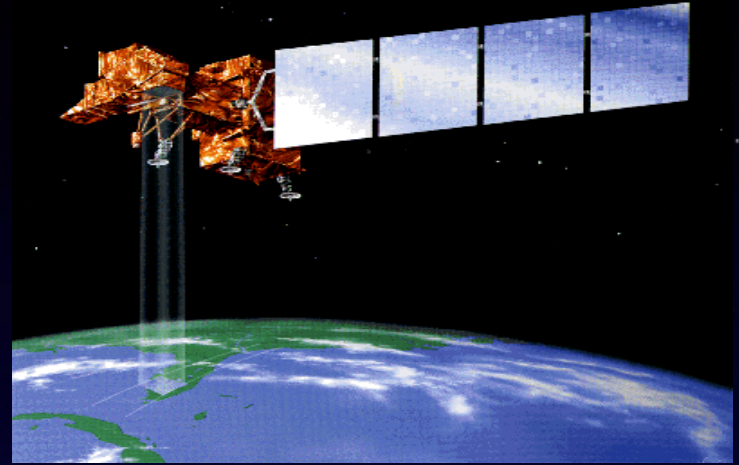
- Spatial Resolution: 1 km
- Spectral Resolution: Two channels are visible / near infrared, 3 channels thermal infra-red
- NOAA-12, NOAA-14, and NOAA-15 are currently in use.
- NOAA-15 is the latest in the series and launched at 1998.

AVHRR Image (NOAA-14)

04/17/2000

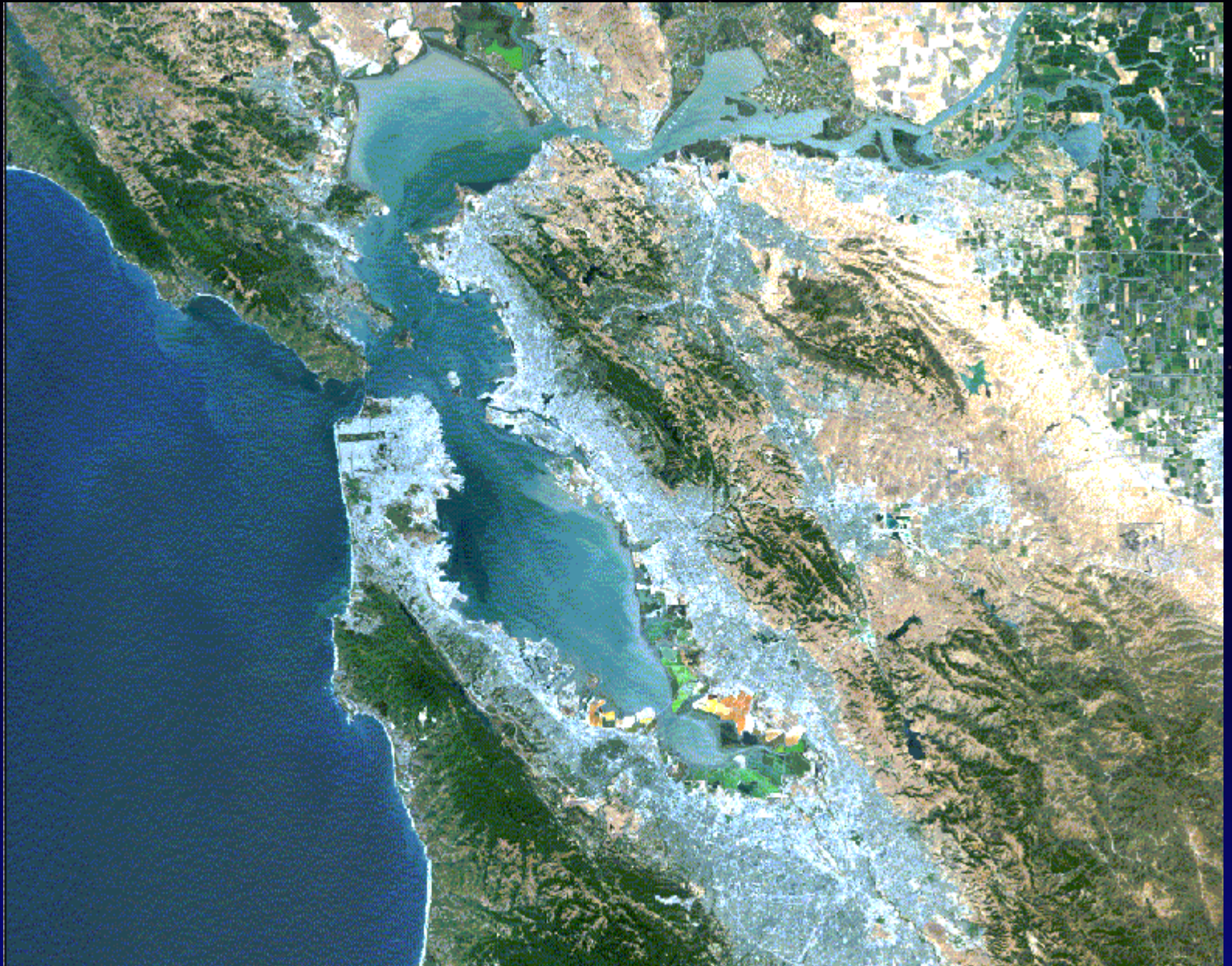


LANDSAT

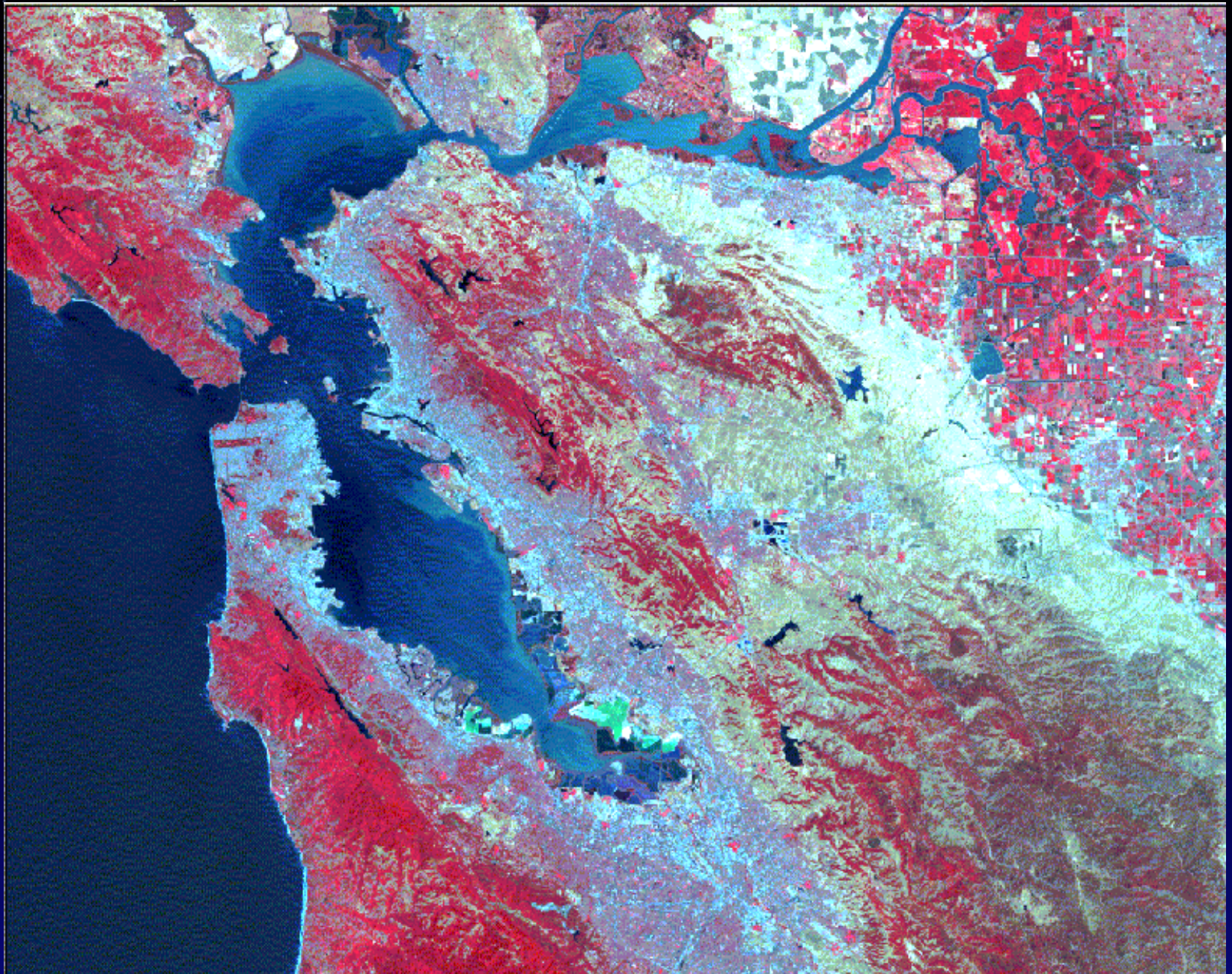


- Spatial Resolution: 30 m multispectral or 15 m panchromatic
- Spectral Resolution: 7 multispectral bands in visible (3), reflected infra-red (3), and thermal infrared (1).
1 panchromatic band

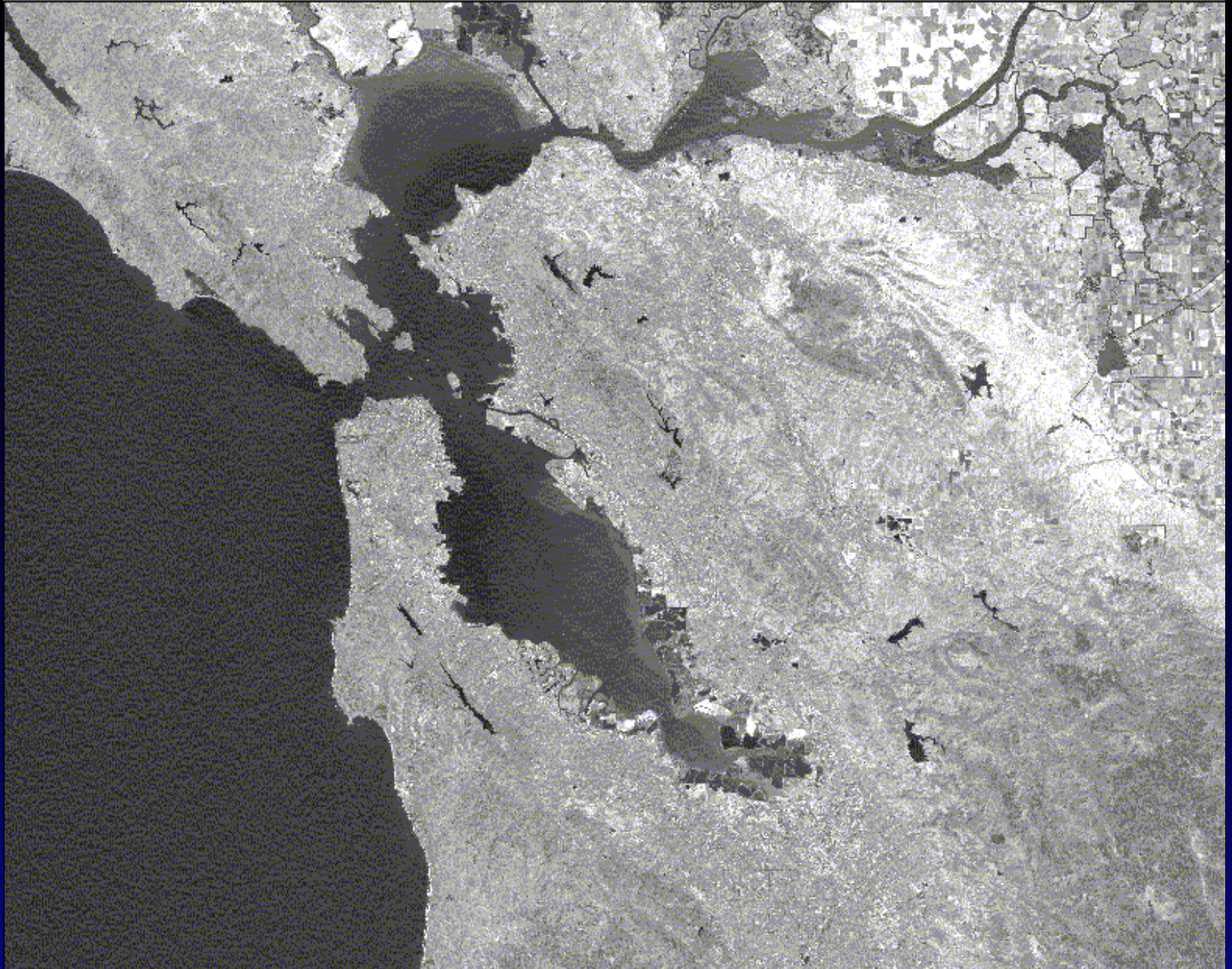
Landsat 7 True Color (Bands 3,2,1)



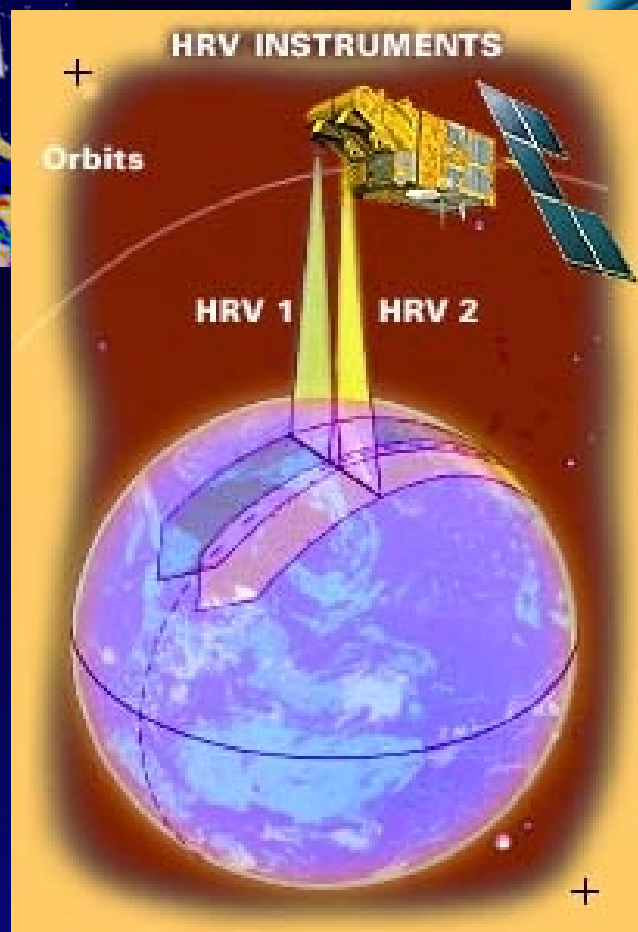
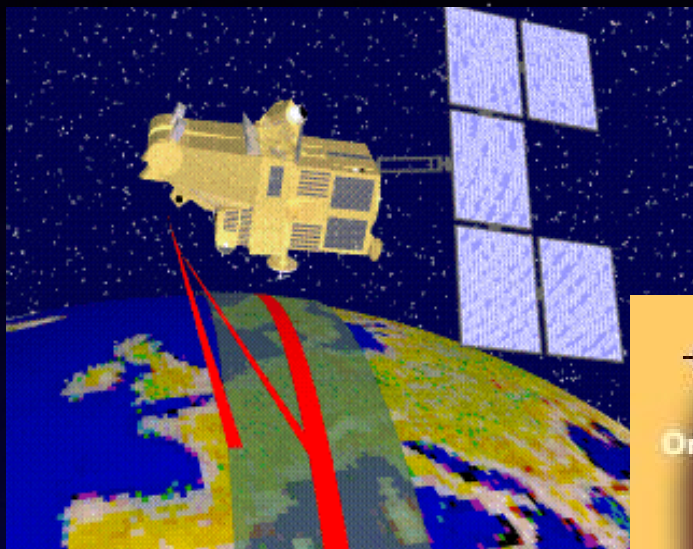
Landsat 7 (30m, Bands 4, 3, 2)



Landsat 7 Panchromatic Band-8 (15m)



SPOT 4

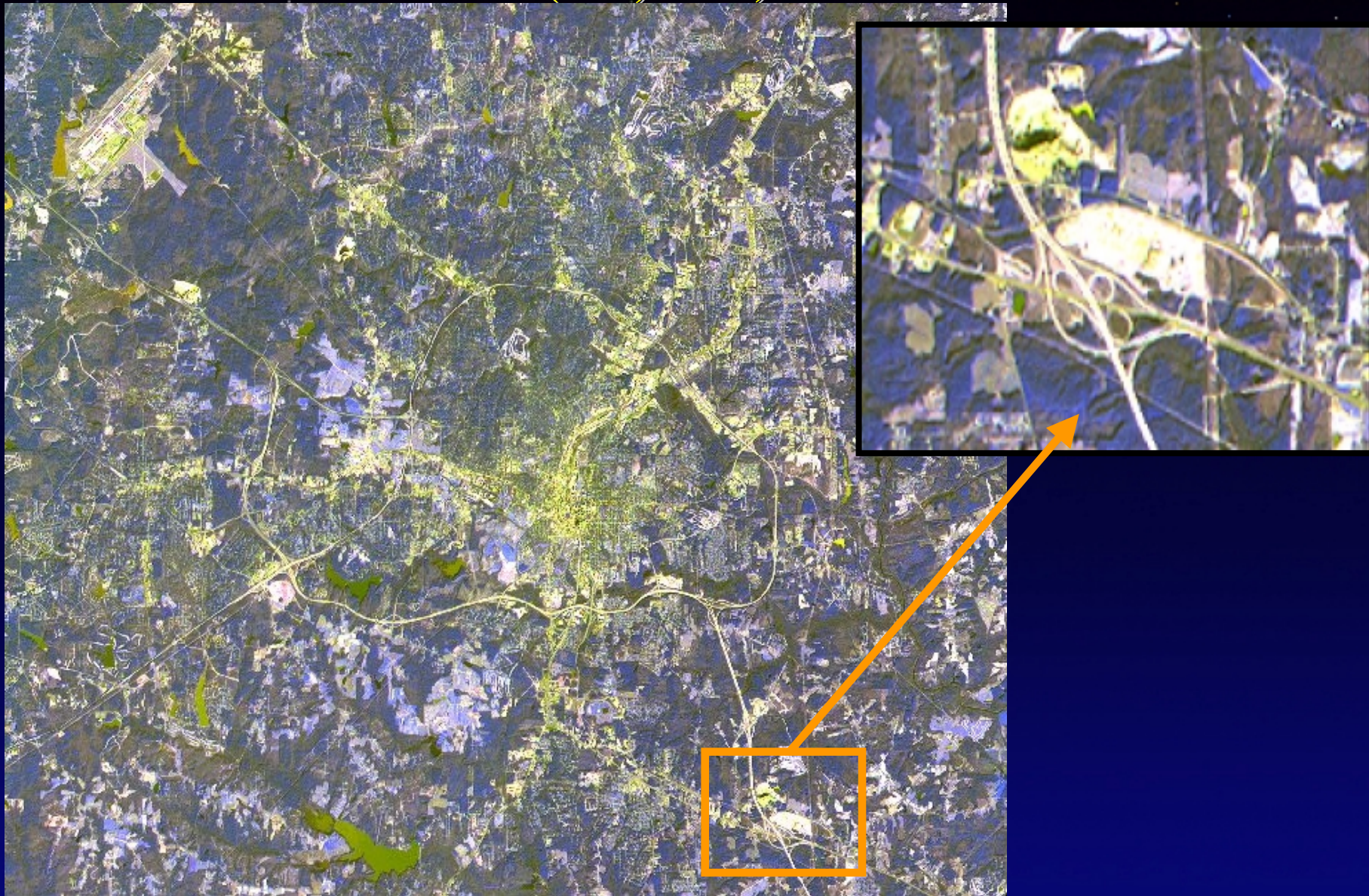


SPOT 4 Characteristics

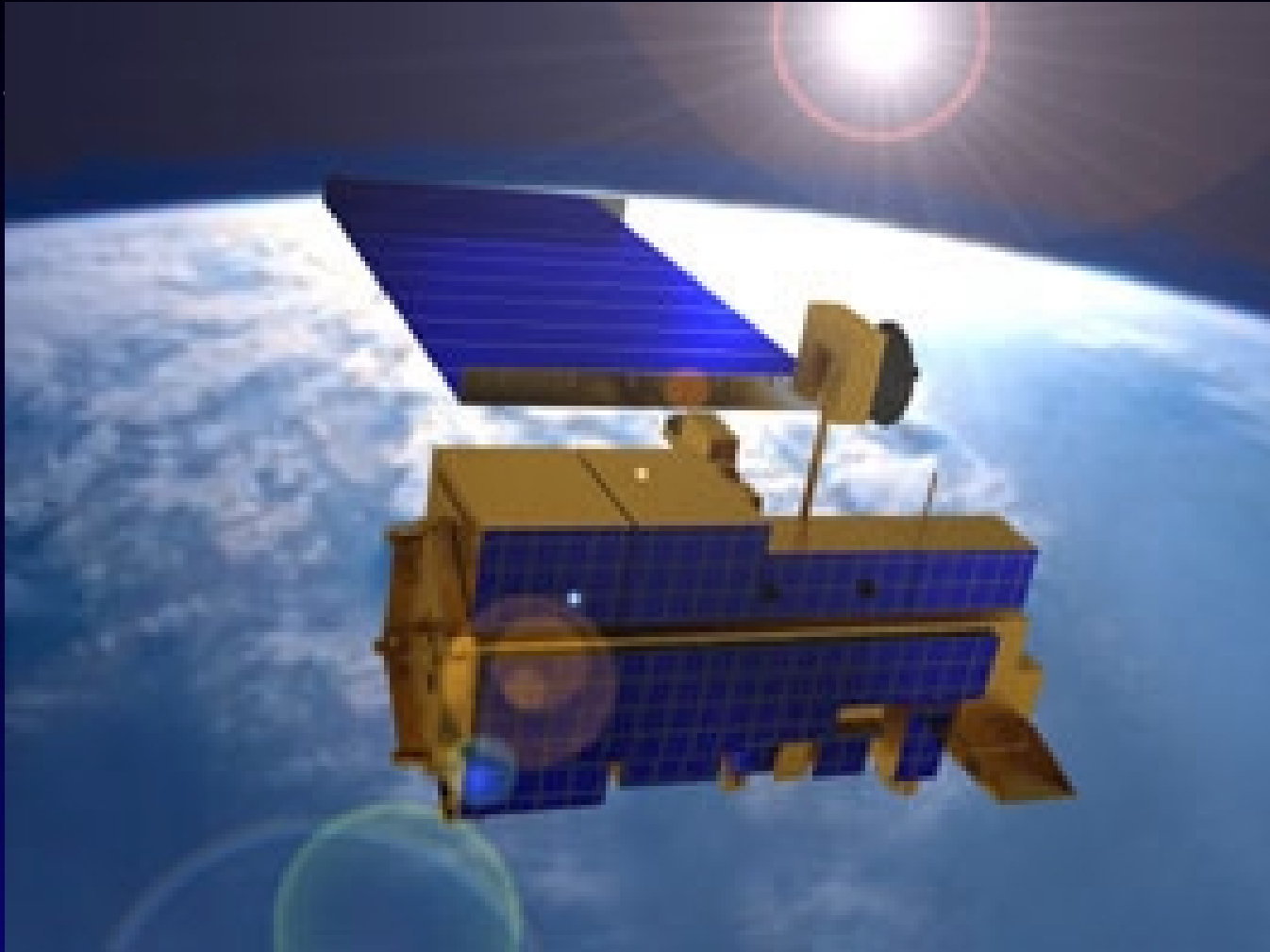
- Spatial Resolution: 20 m multispectral, 10 m panchromatic
- Spectral Resolution: 4 multispectral bands in visible (2) and reflected infra-red (2), 1 panchromatic band

SPOT Image of Raleigh, NC

(Jan, 1986)



NASA's Terra Satellite



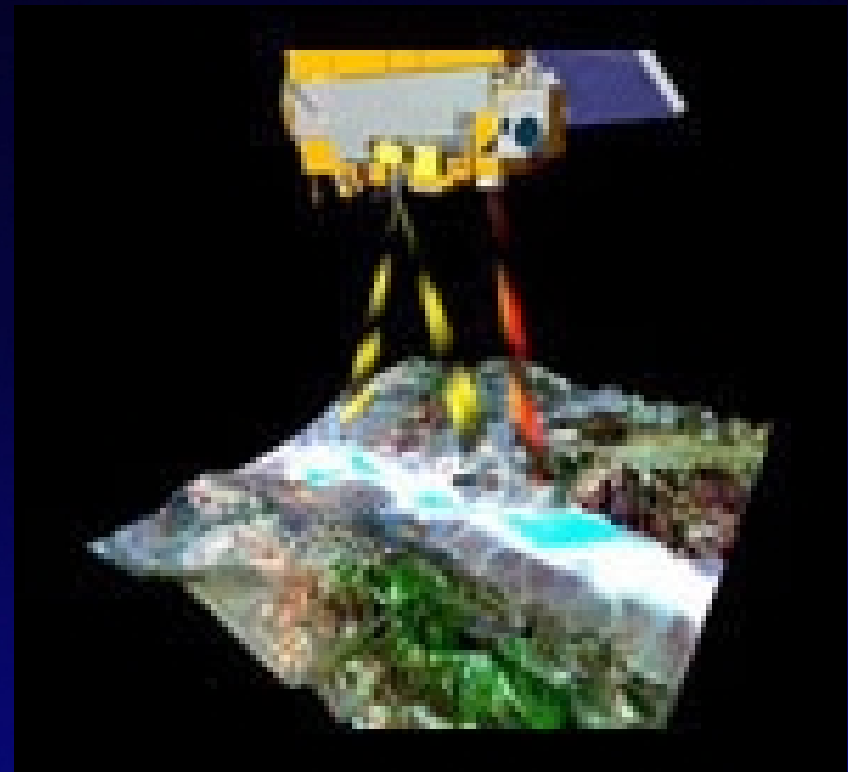
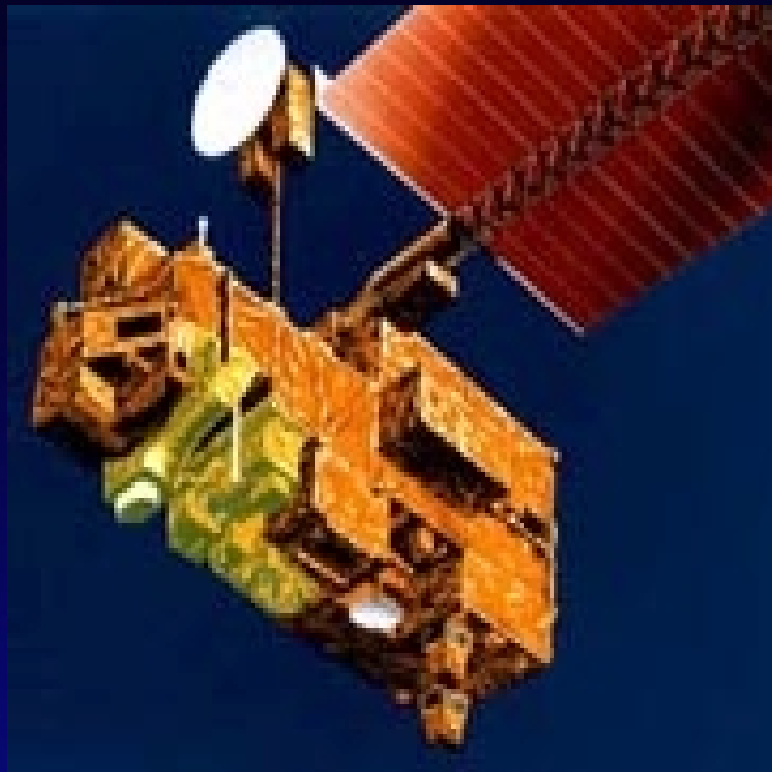
Terra Satellite

Sensors on board:

- **ASTER:** Advanced Spaceborne Thermal Emission and Reflection Radiometer
- **MODIS:** MODerate resolution Imaging Spectroradiometer
- **CERES:** Clouds and the Earth's Radiant Energy System
- **MOPITT:** Measurement of Pollution in the Troposphere
- **MISR:** Multi-angle Imaging Spectro-Radiometer

ASTER

Advanced Spaceborne Thermal Emission and
Reflection Radiometer

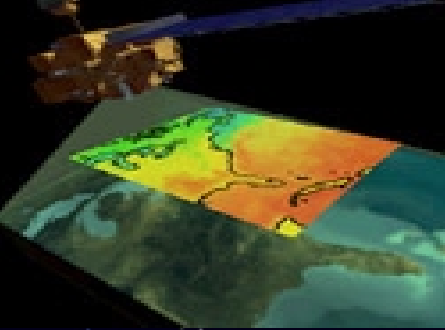


ASTER Instrument Characteristics

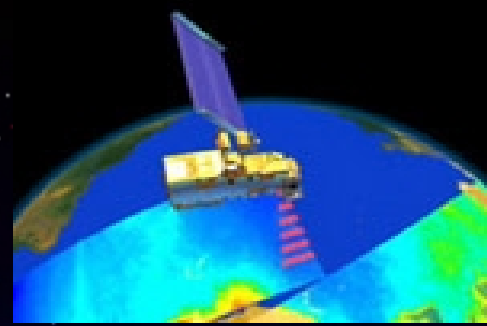
- Three operating ranges: VNIR, SWIR, Thermal IR
- Spatial Resolution: 15 m VNIR, 30 m SWIR, 90 m Thermal IR
- Spectral Resolution: 3 bands in NIR, 6 bands in SWIR, and 5 bands in Thermal IR

ASTER image of San Francisco Bay Area





MODIS

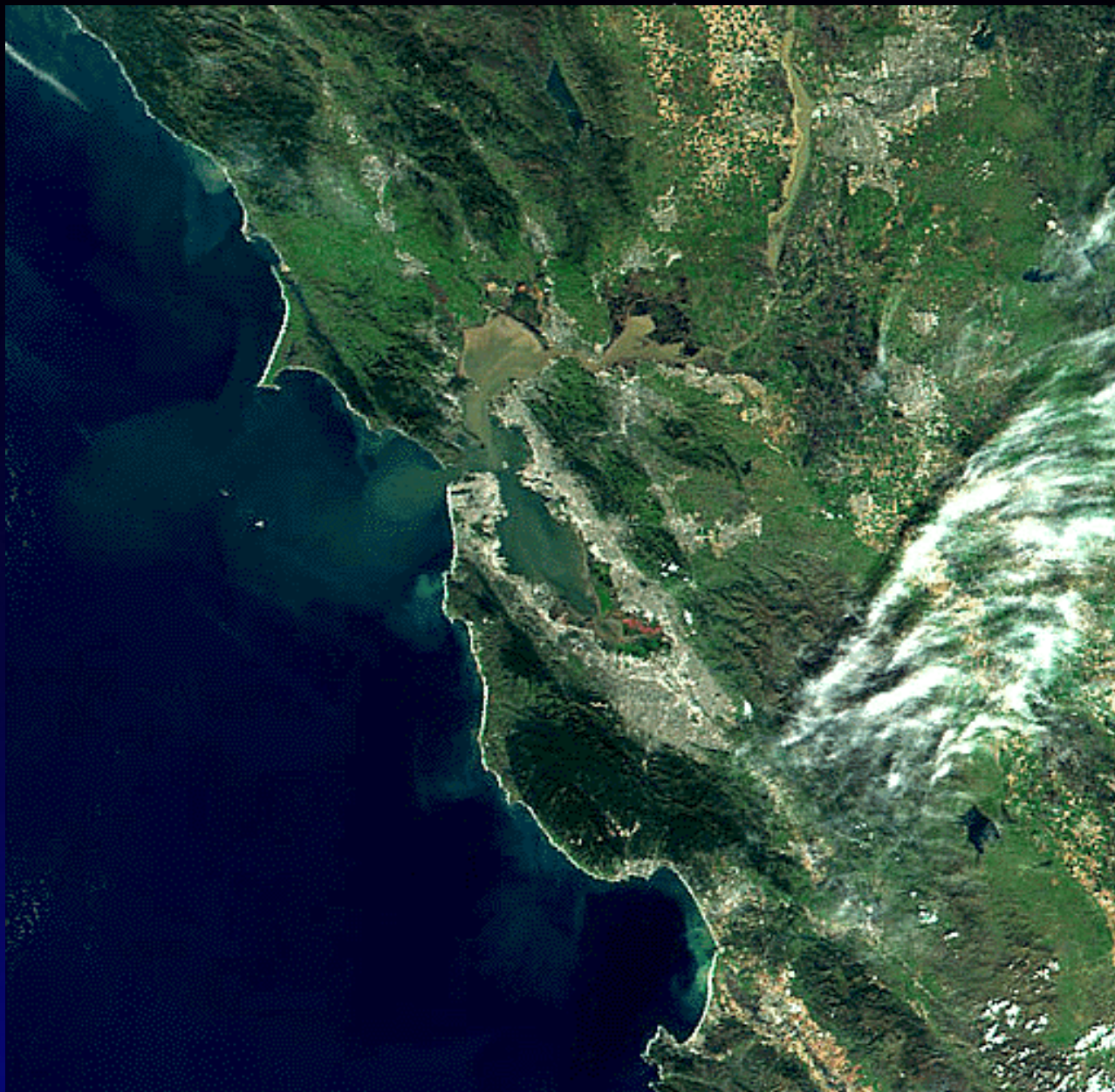


MODerate resolution Imaging Spectroradiometer

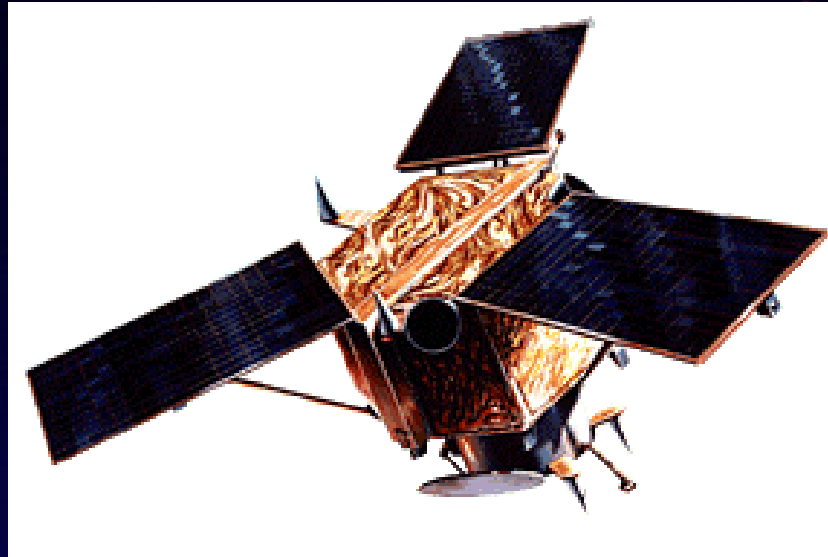
- Spatial Resolution: 250 m (bands 1-2)
500 m (bands 3-7)
1000 m (bands 8-36)

Spectral Resolution: 36 bands ranging from the visible to thermal IR.

Terra MODIS Image (4/2000)



IKONOS



Space Imaging Inc.

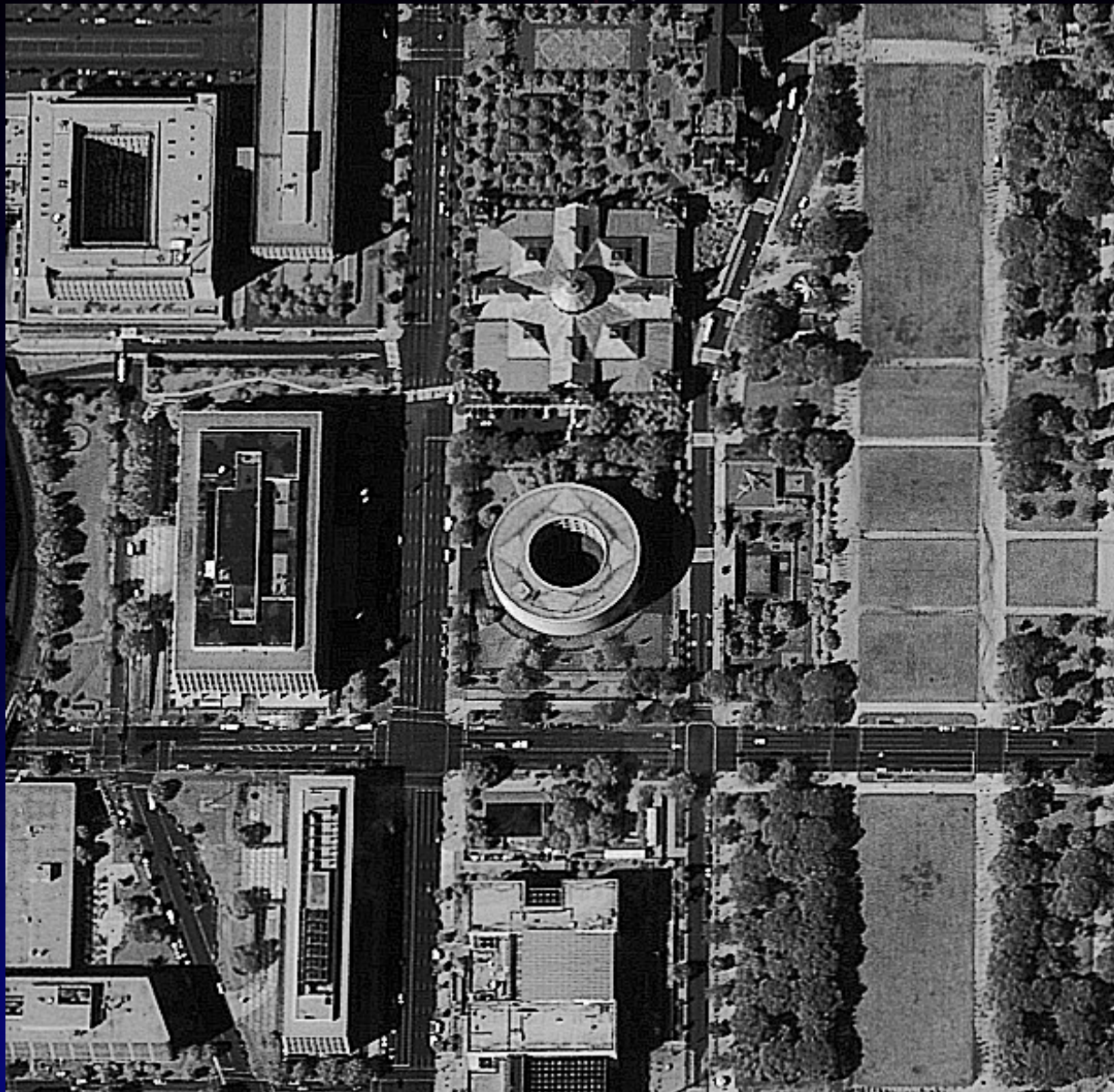
September 1999

IKONOS Specifications

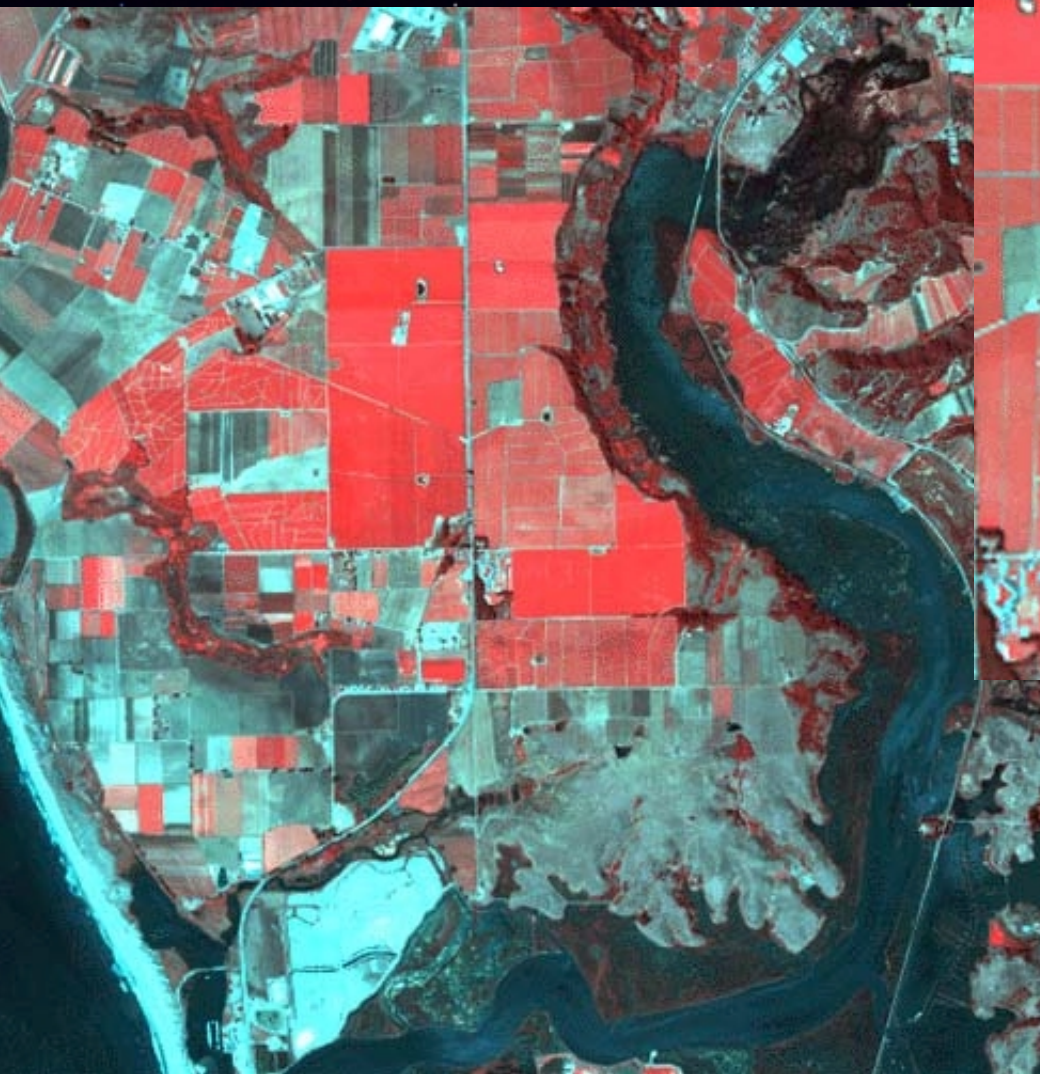
- Spatial Resolution: 4 m multispectral or 1 m panchromatic
- Spectral Resolution: 4 multispectral bands in visible (3), reflected infra-red (1), 1 panchromatic band

First IKONOS Image (part)

Hirshorn Museum and Sculpture Garden, Washington D.C.



IKONOS



Monterey, California (enlargement)

Four-meter multispectral image of Monterey, California. Displayed with the near-infrared band, this imagery is useful for assessing vegetative health.

Monterey, California (full) March, 2000

IKONOS



Vienna, Austria (enlargement)

One-meter pan-sharpened image of Vienna, Austria. Shown here are the Imperial Palace and gardens. This imagery is useful for transportation network monitoring, tourism, real estate and other applications

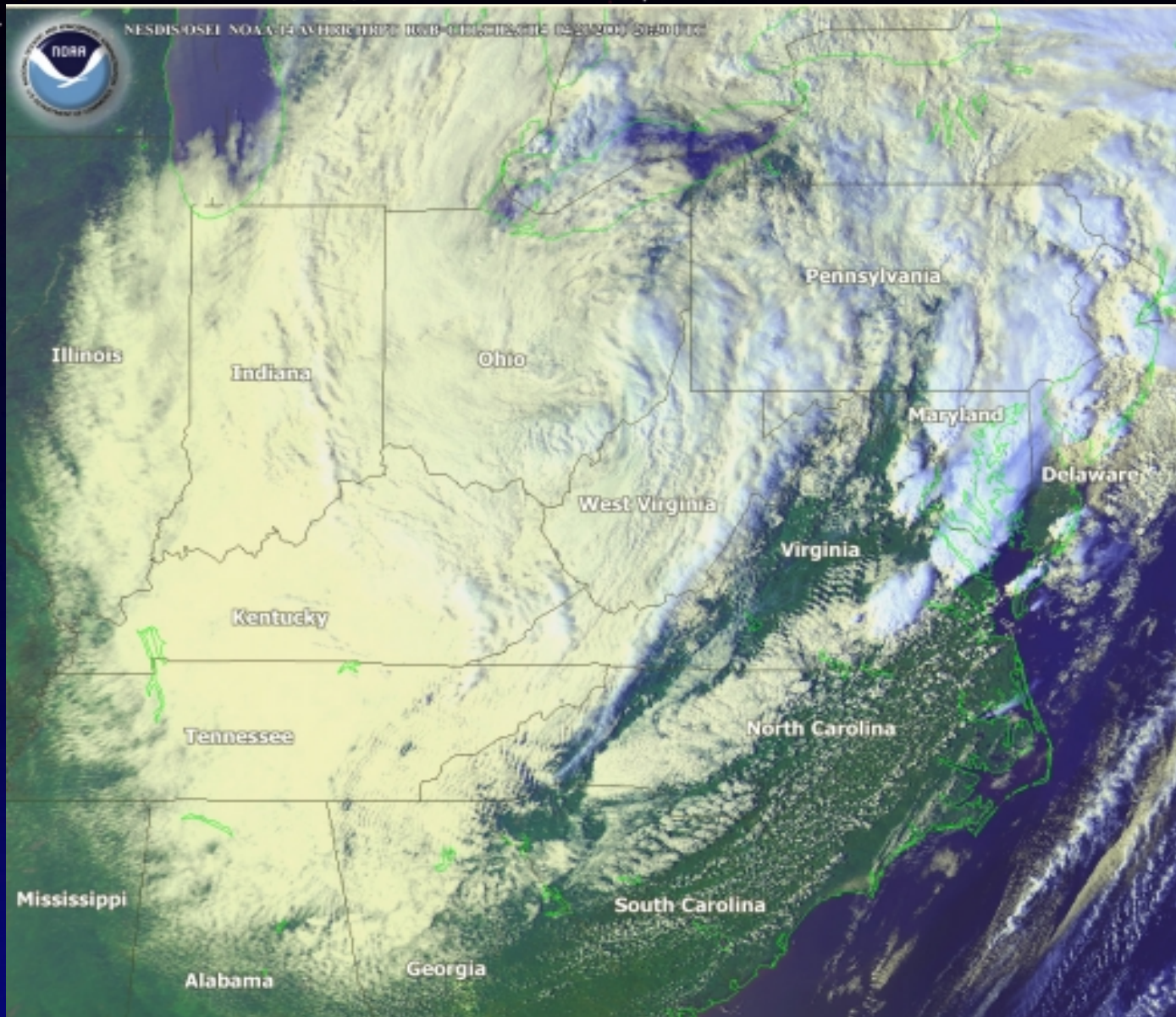
Vienna, Austria (full) April 2000

Major Applications of Remote Sensing

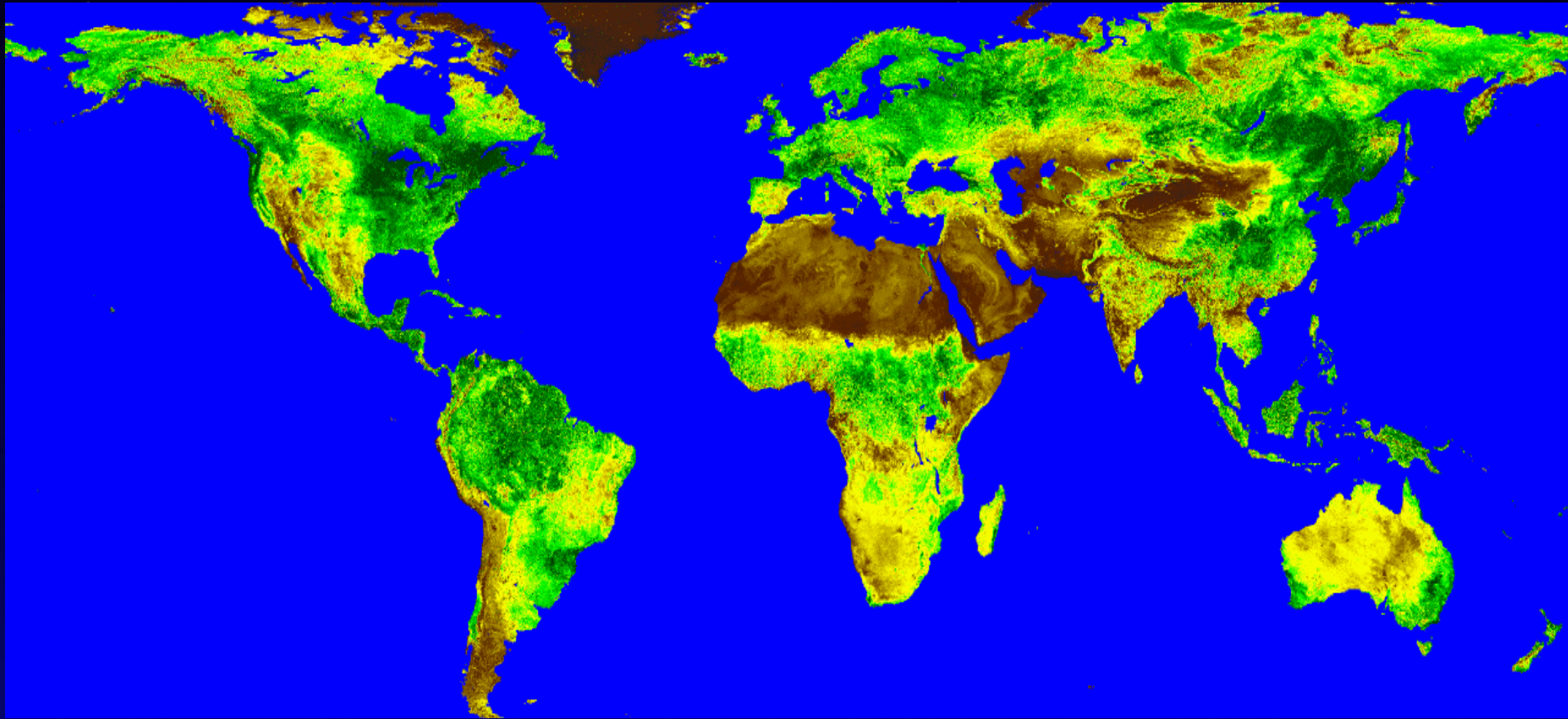
- Agriculture
- Municipal Planning
- Land Use And Land Cover Analysis
- Cadastral Mapping
- Cartography And Topography
- Urban Planning
- Forestry
- Natural Reserve Management And Planning
- Natural Hazard And Pollution Monitoring
- Geology, Mineral And Oil Exploration
- Water Resources
- Coastal And Ocean Studies
- Weather Forecasting

AVHRR Image (NOAA-14)

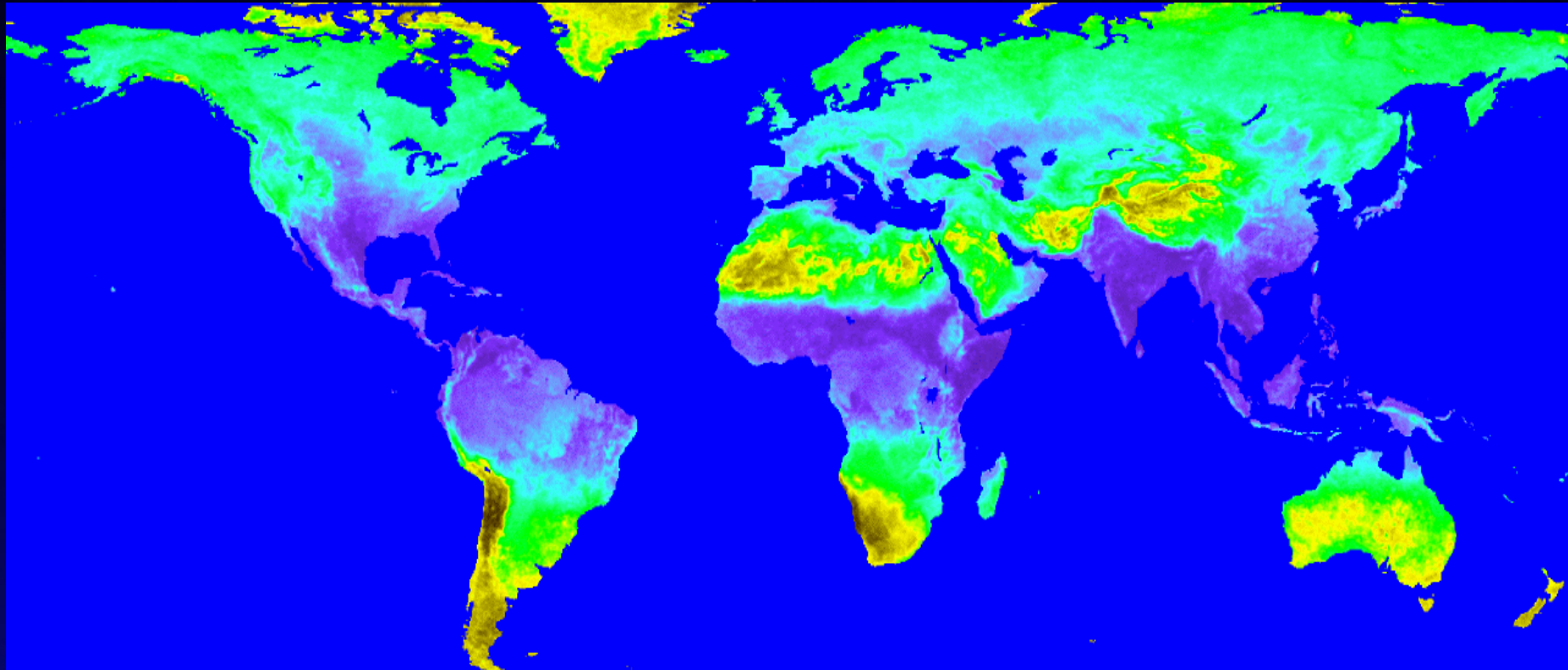
4/21/2000



World Vegetation Cover

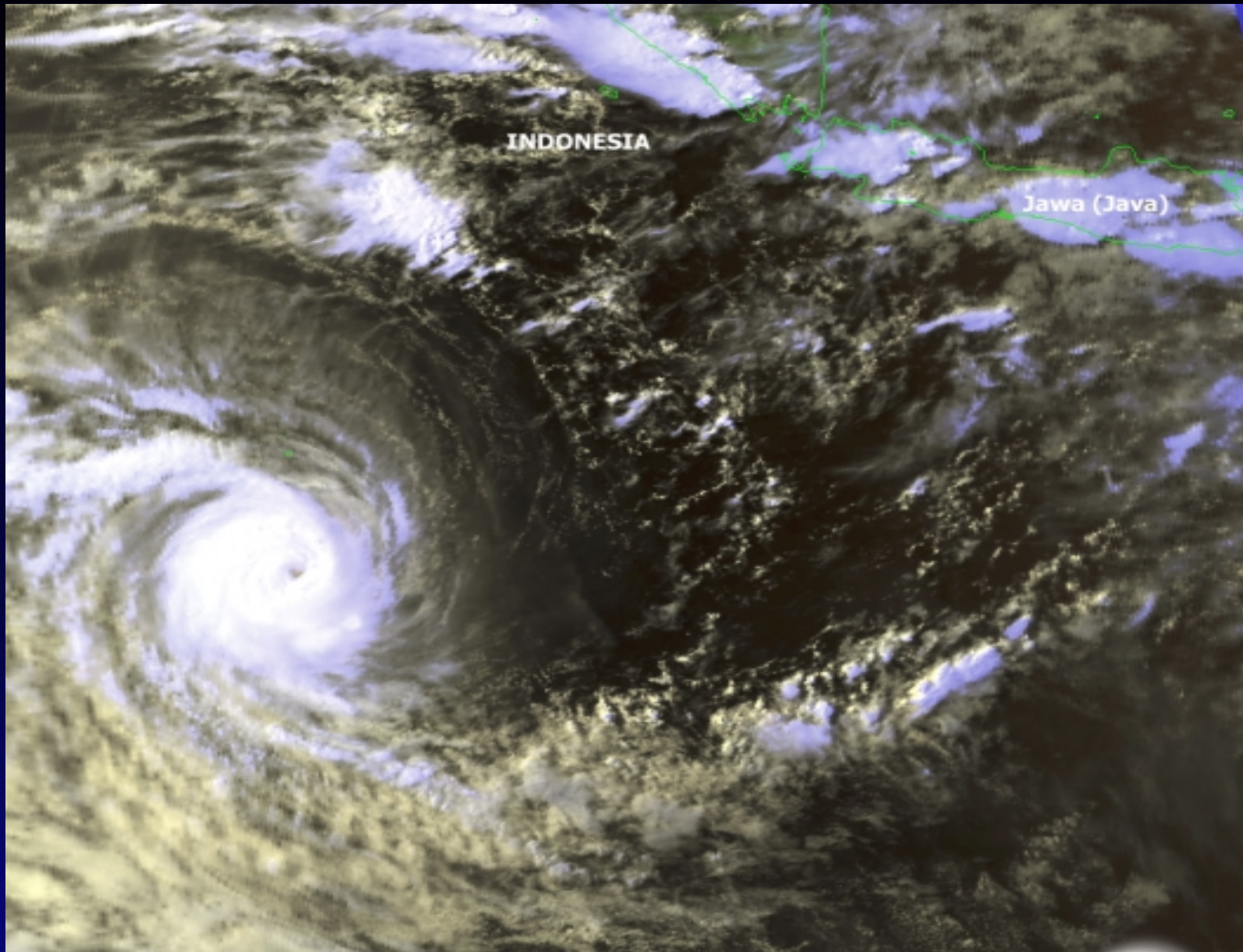


World Precipitable Water Index Image



NOAA-14 (AVHRR) Tropical Cyclone

4/17/2000

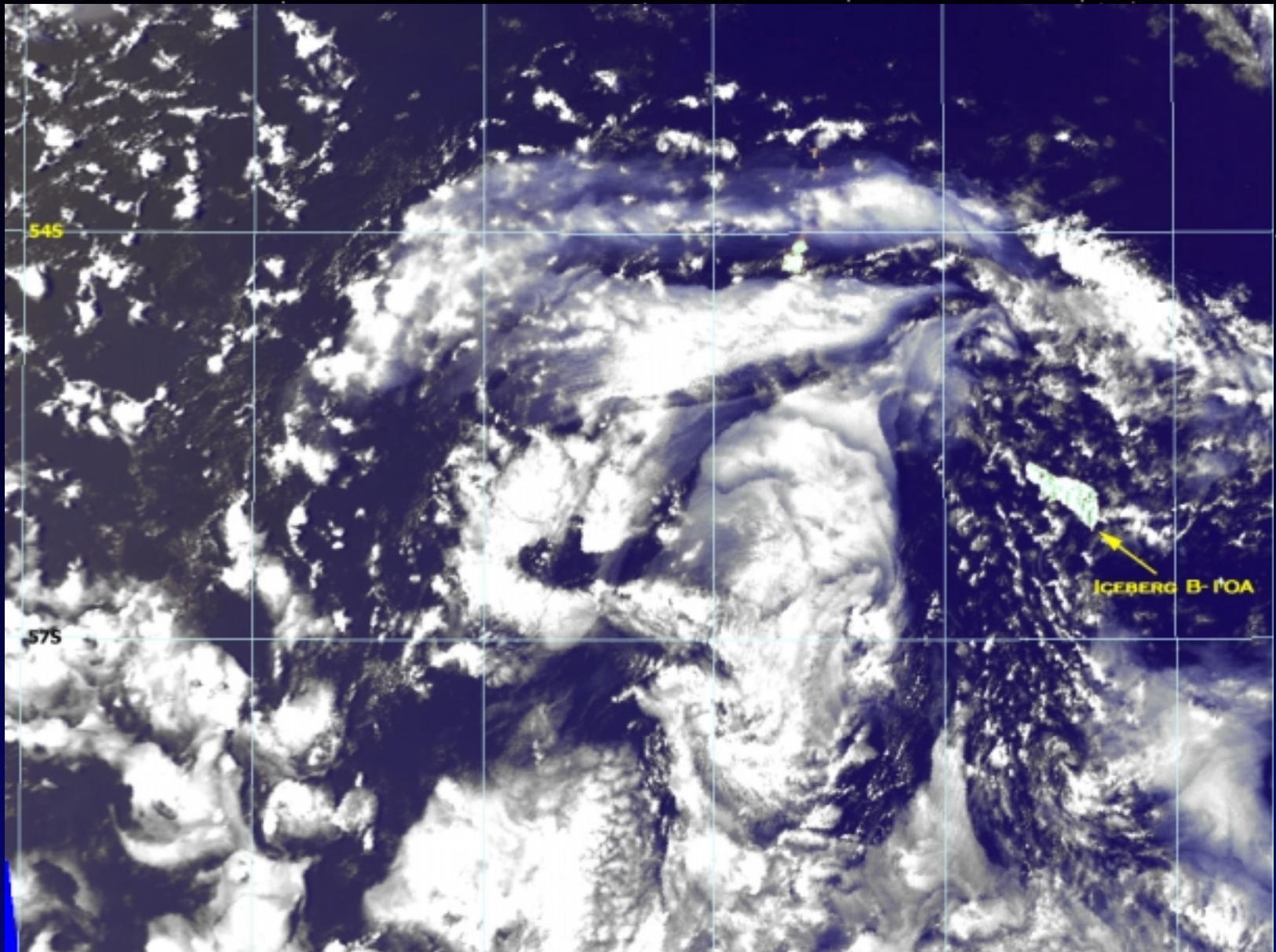


FLORIDA FIRES (NOAA-14)

5/2000

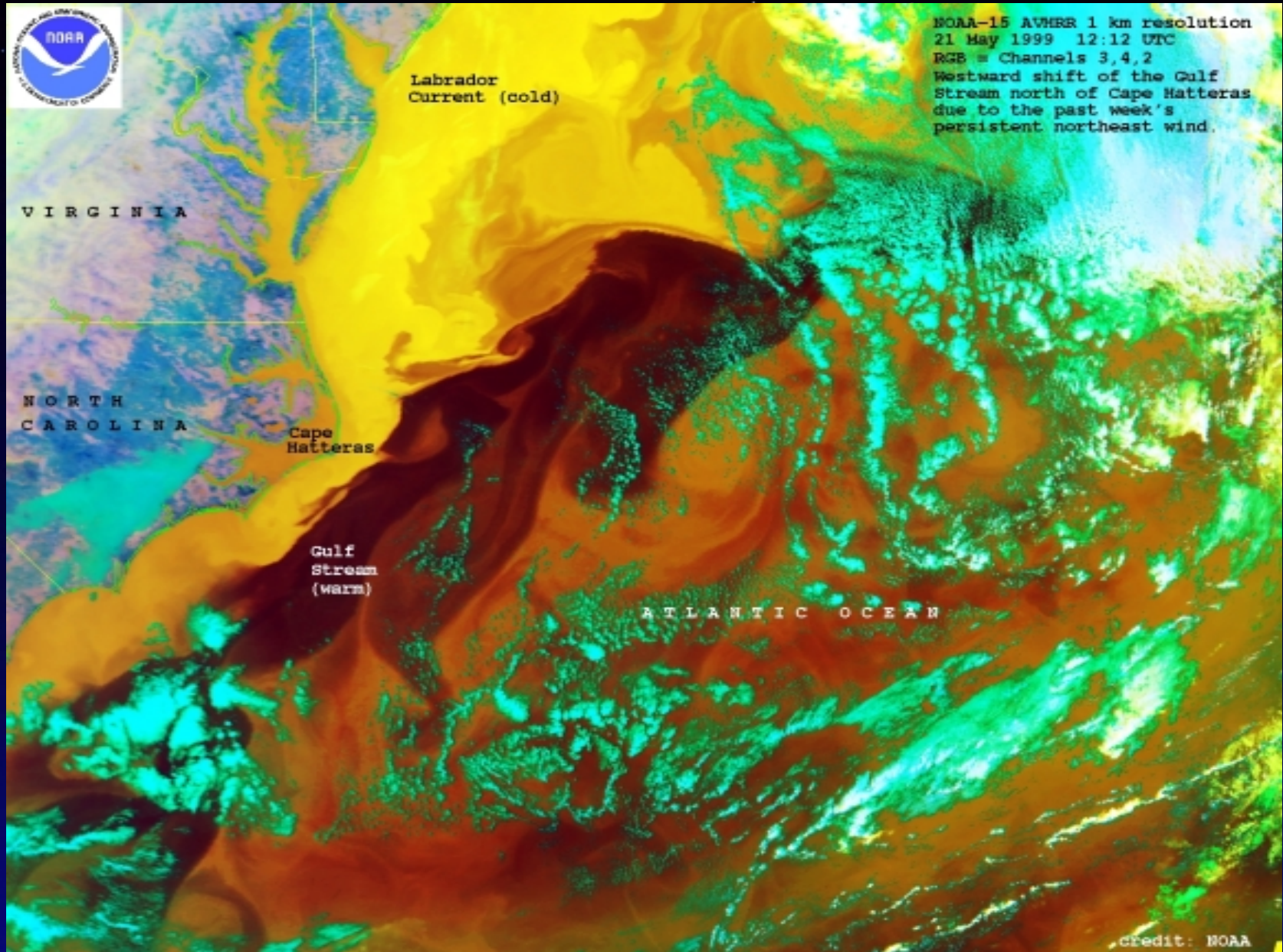


ICEBERG (NOAA-15)



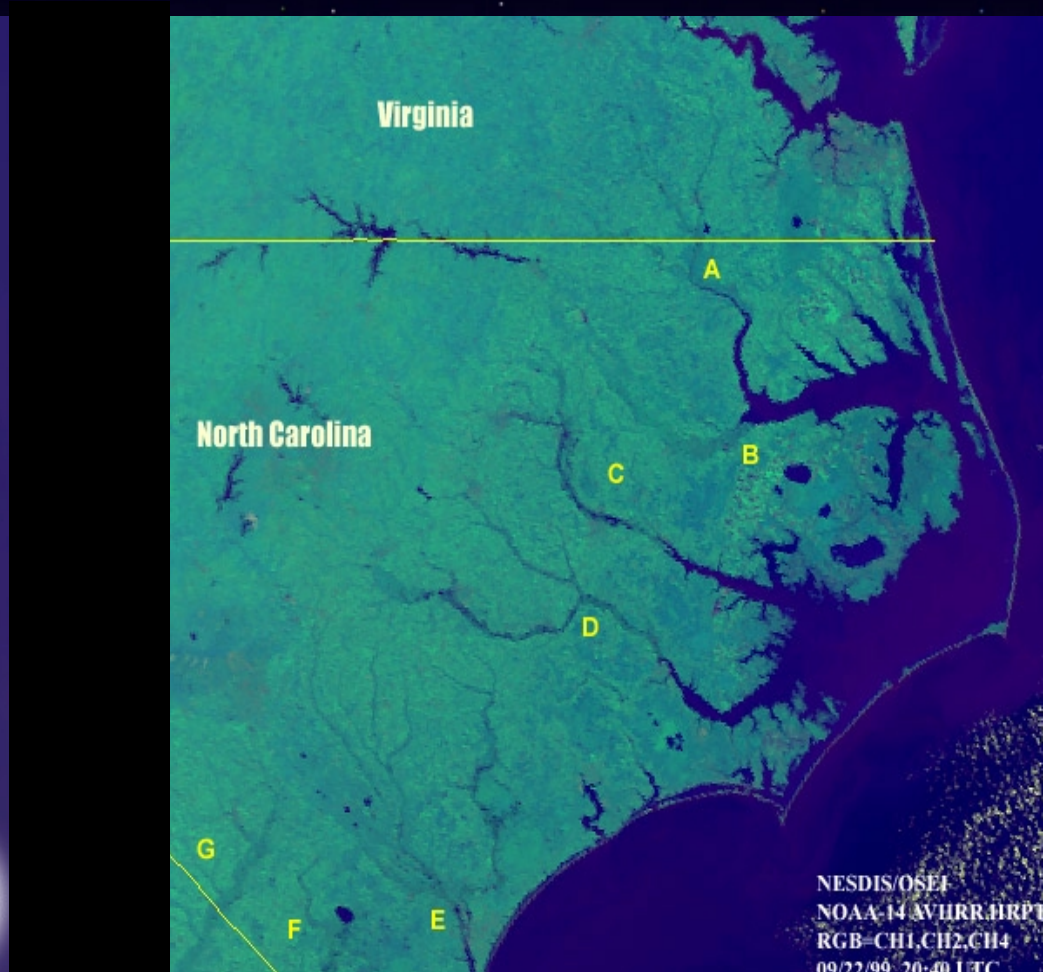
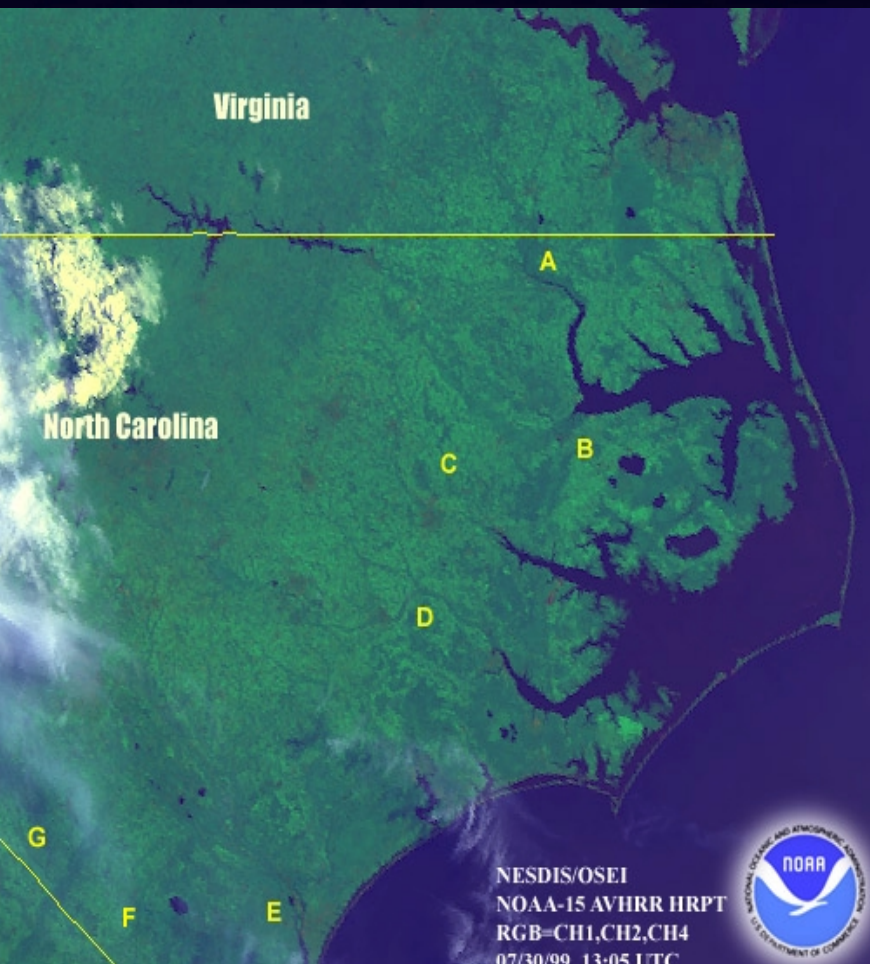
Ocean Temperature (NOAA-15)

5/21/1999

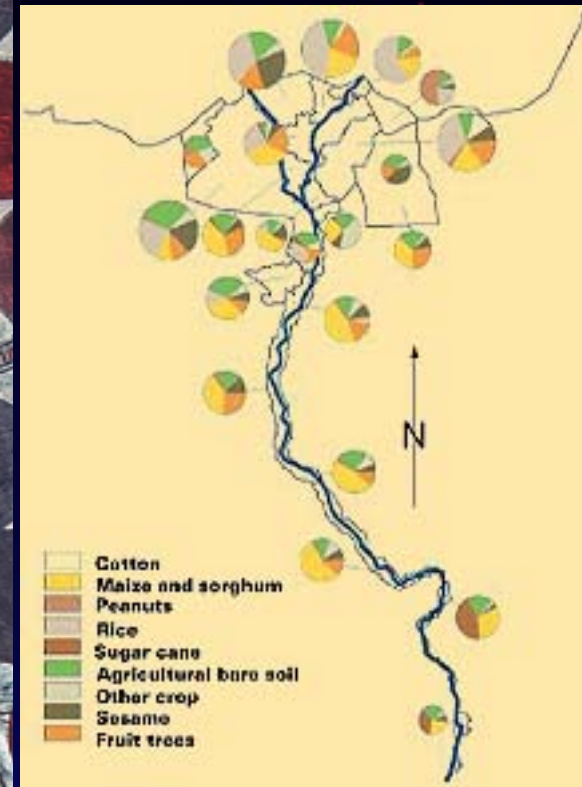
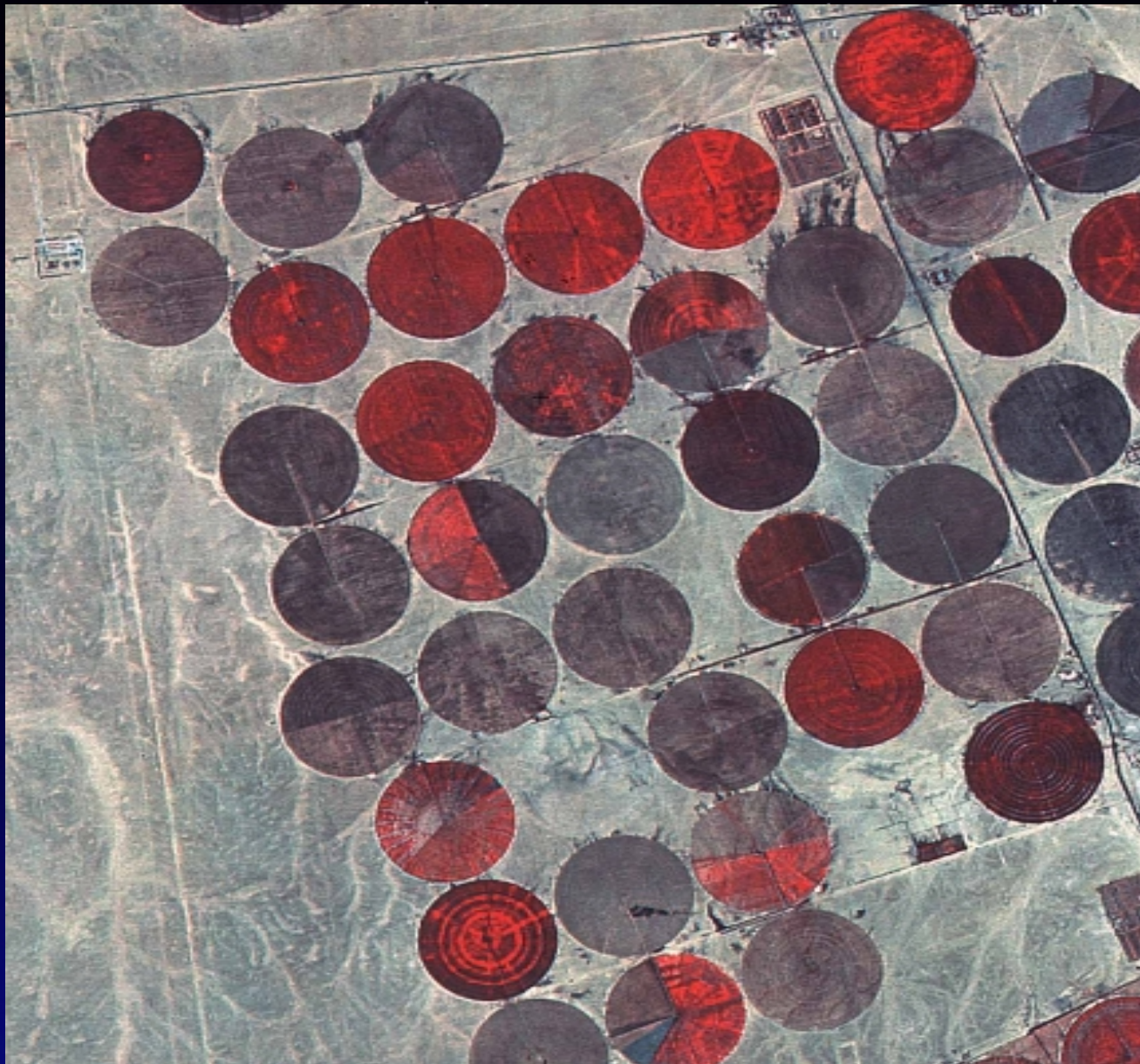


FLOODING

(Rivers in NC before and after Hurricane Floyd)
07/30/1999 09/22/1999

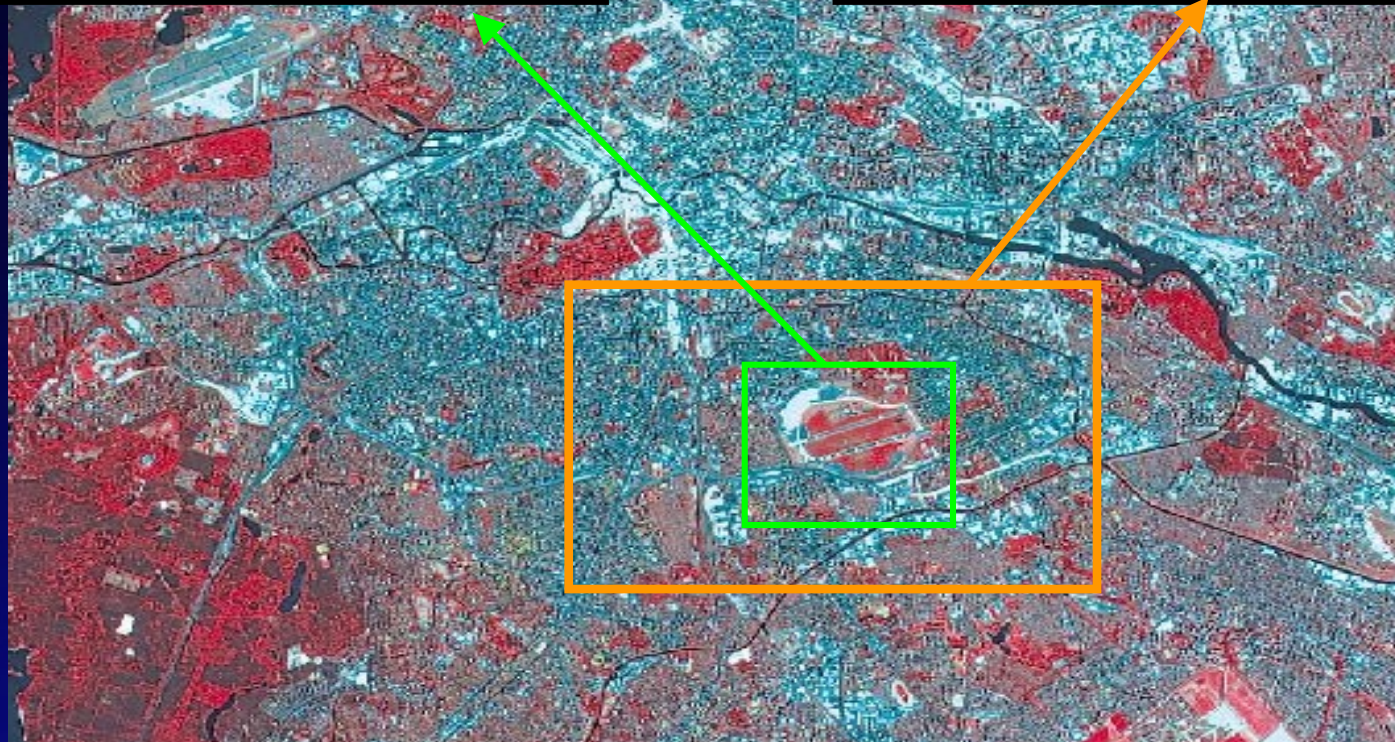


SPOT Image Usage on Agriculture



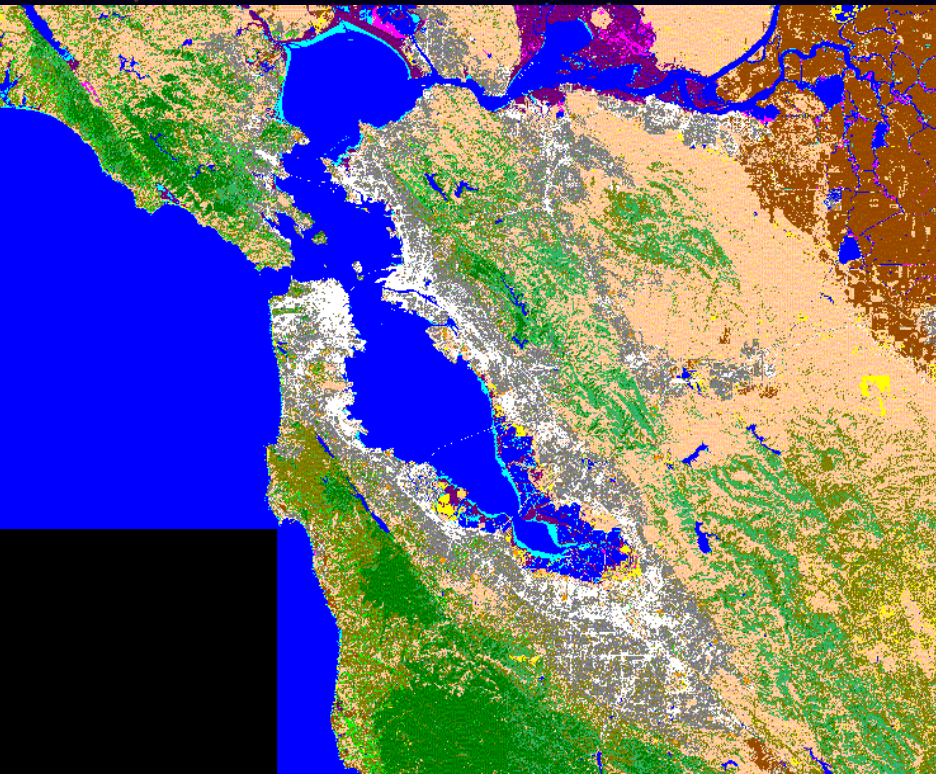
Urban Planning (SPOT)

Berlin, Germany

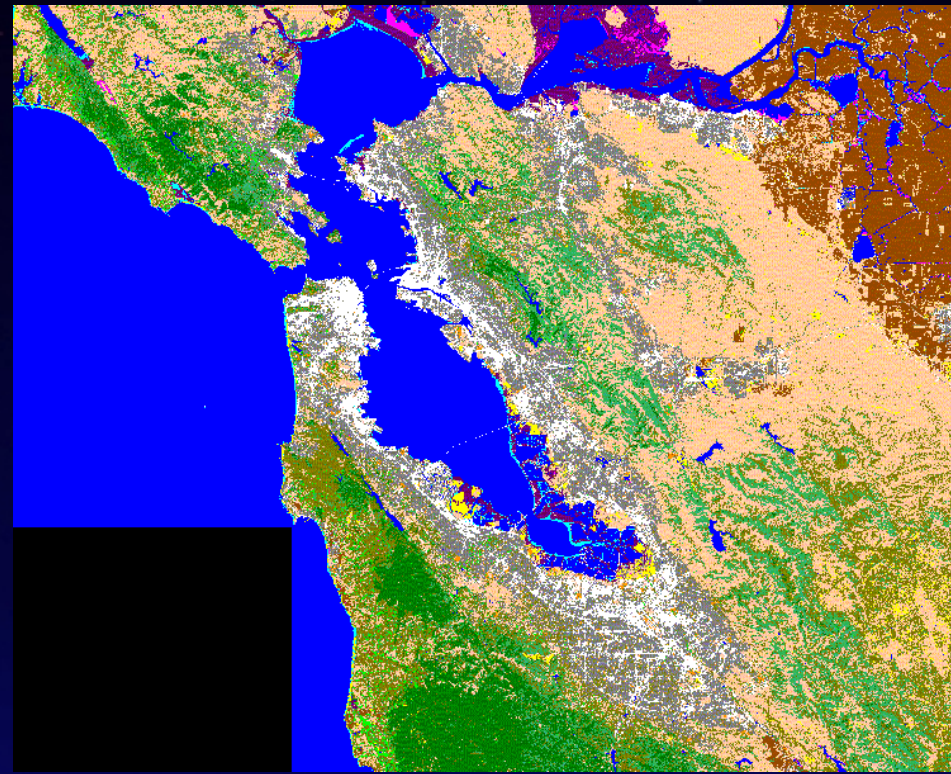


Land Cover Change Analysis

1986 Land Cover Classification



1993 Land Cover Classification



Legend for Land Cover Change Imagery

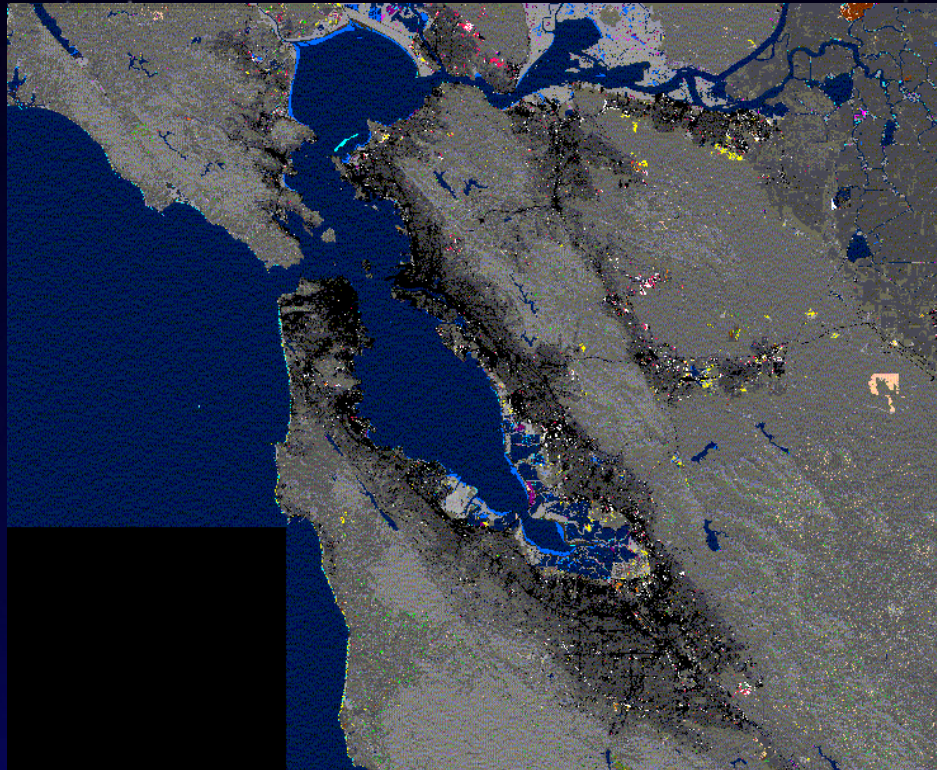
Algal	Grass
Bare	Grass Managed
Cultivated	Mixed Forest
Deciduous Forest	Palustrine Emergent
Developed High	Scrub/Shrub
Developed Low	Unconsolidated Shore
Estuarine Emergent	Water
Evergreen Forest	Shades of gray represent no change

Legend for Land Cover Imagery

Algal	Grass
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Evergreen Forest	

Land Cover Change Analysis

Land Cover Change Image

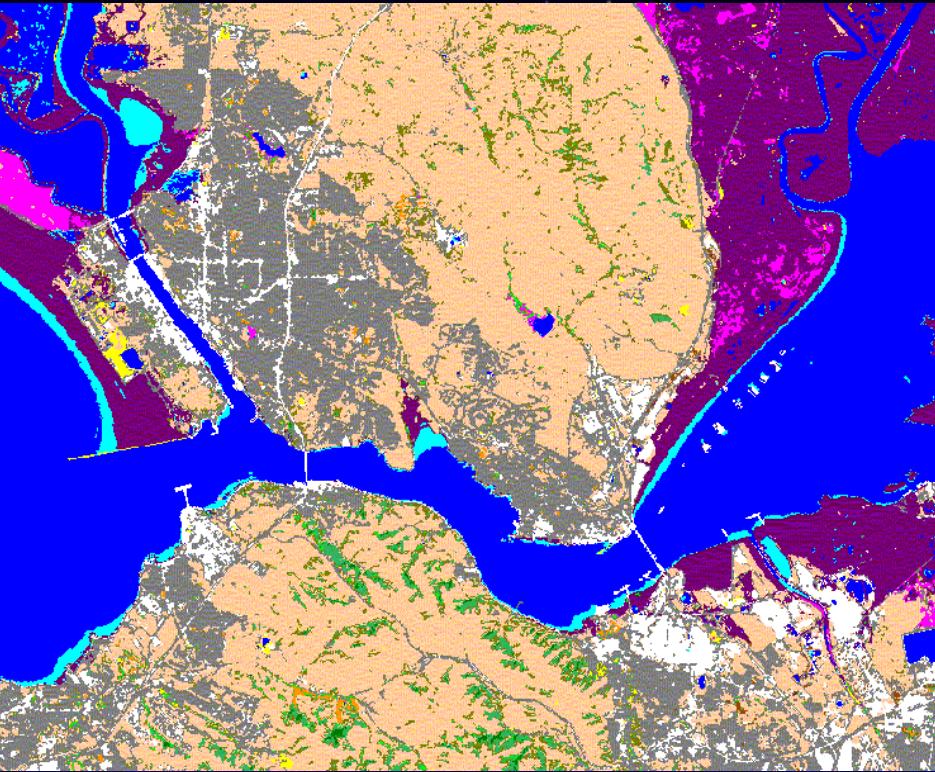


Legend for Land Cover Change Imagery

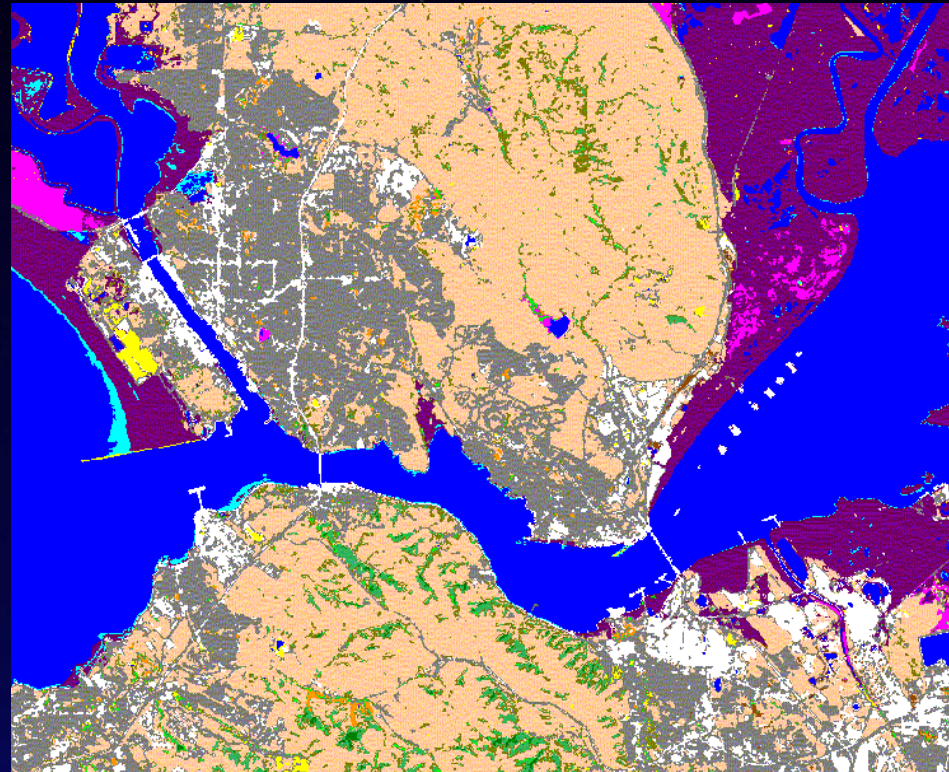
Algal	Grass
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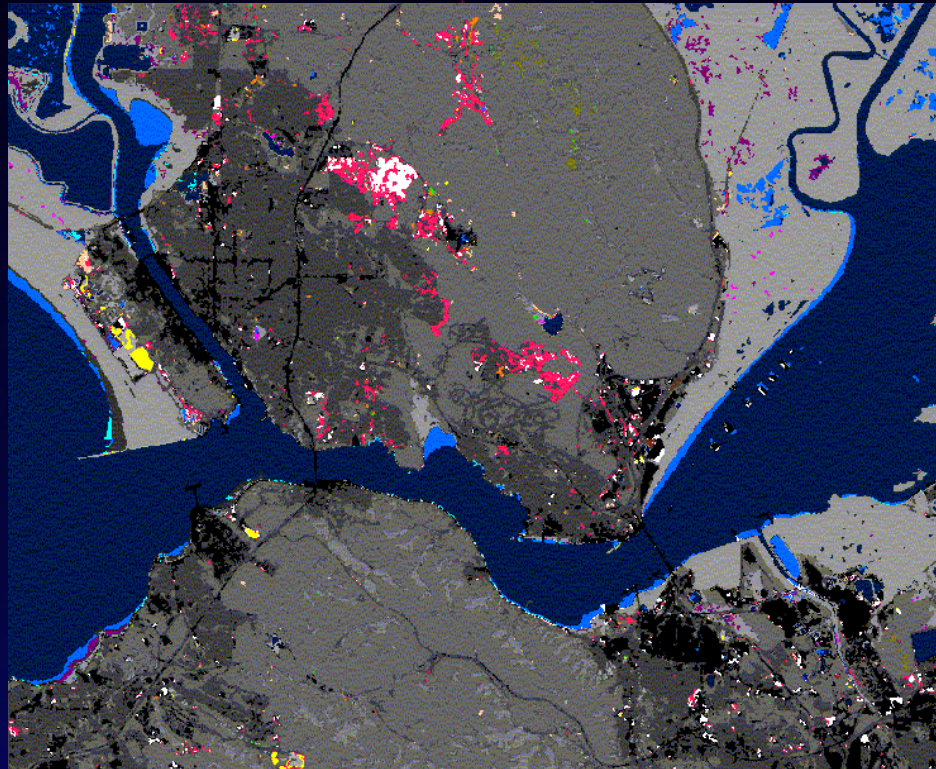


Legend for Land Cover Imagery

Algal	Grass
Bare	Grass Managed
Cultivated	Mixed Forest
Deciduous Forest	Palustrine Emergent
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Developed Low	Unconsolidated Shore
Estuarine Emergent	Water
Evergreen Forest	

Land Cover Change Analysis

Land Cover Change Image



Legend for Land Cover Change Imagery

Algal	Grass
Bare	Grass Managed
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Deciduous Forest	Palustrine Emergent
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Evergreen Forest	Shades of gray represent no change

Agricultural Development

Kansas, USA

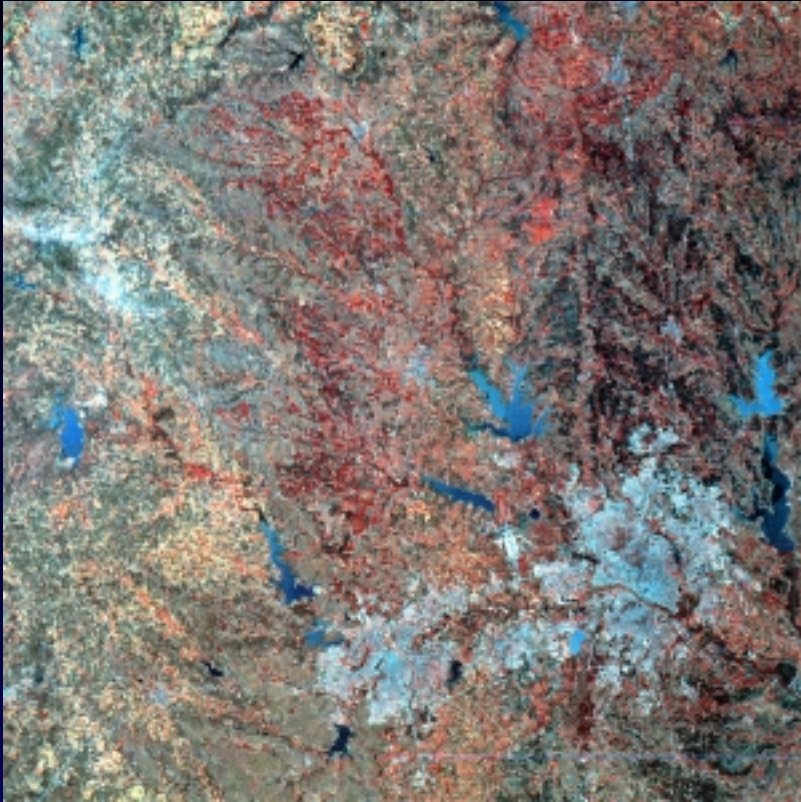


August 16, 1972



August 15, 1988

Urban Growth: Dallas-Fort Worth, Texas



March 12, 1974

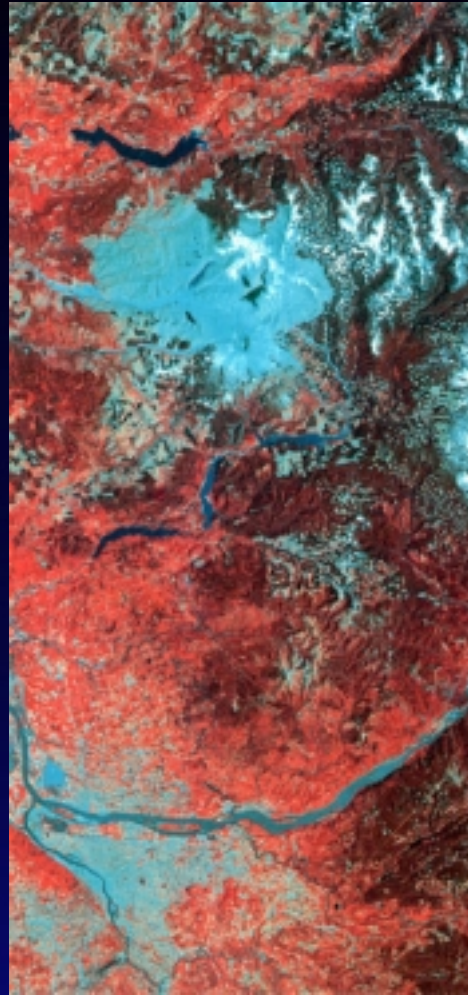


March 22, 1989

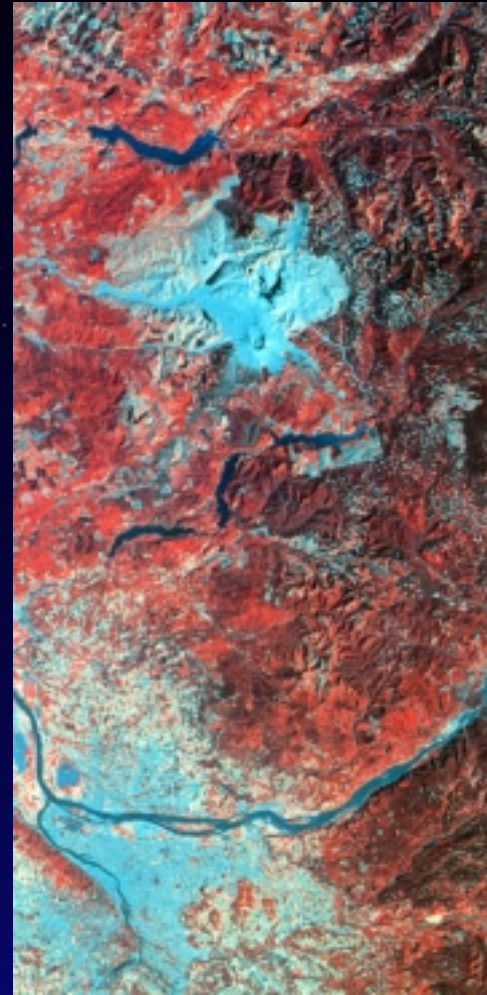
Natural Disasters: Mount St. Helens



September 15, 1973



May 22, 1983



August 31, 1988

Natural Disasters: Floods in Missouri



September 24, 1992

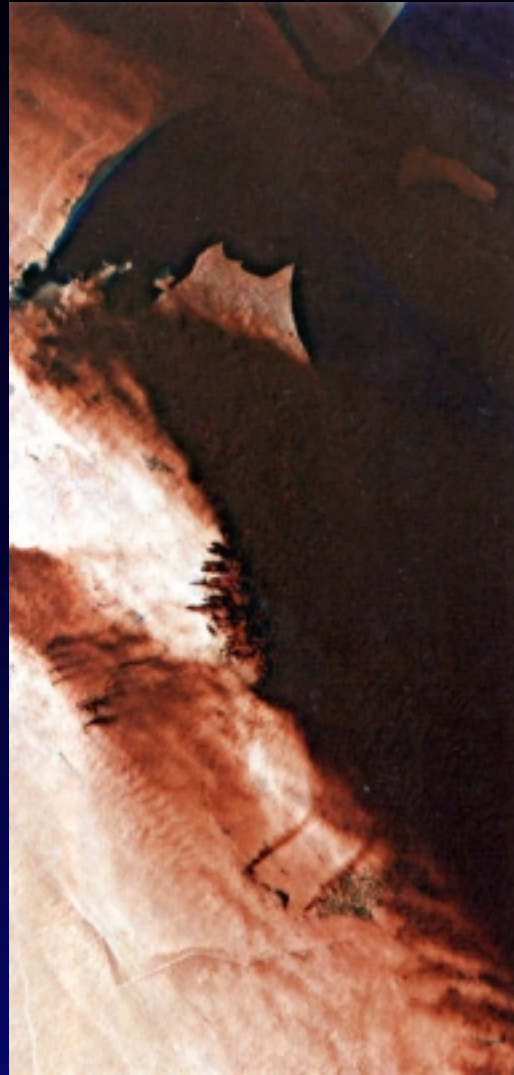


September 27, 1993

Man-made Disasters: Kuwait



August 31, 1990



February 23, 1991

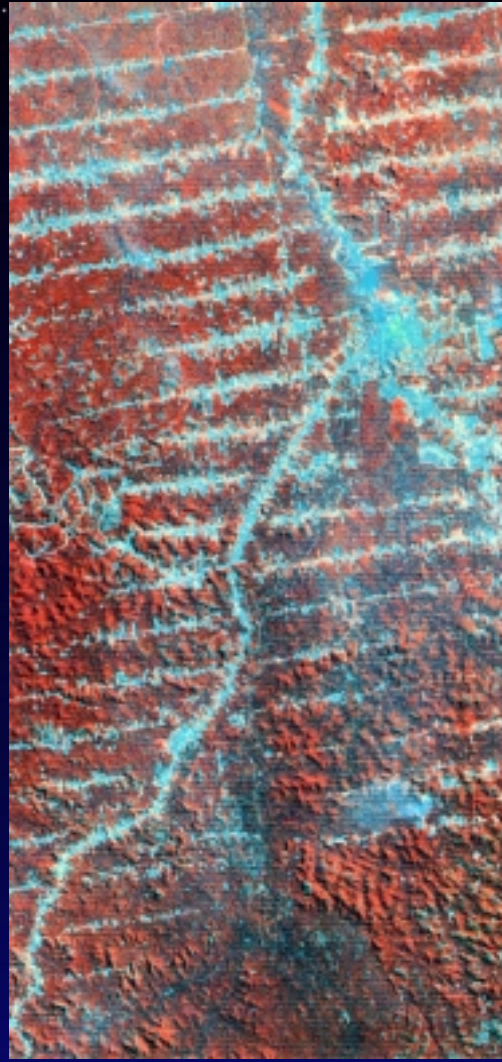


November 14, 1991

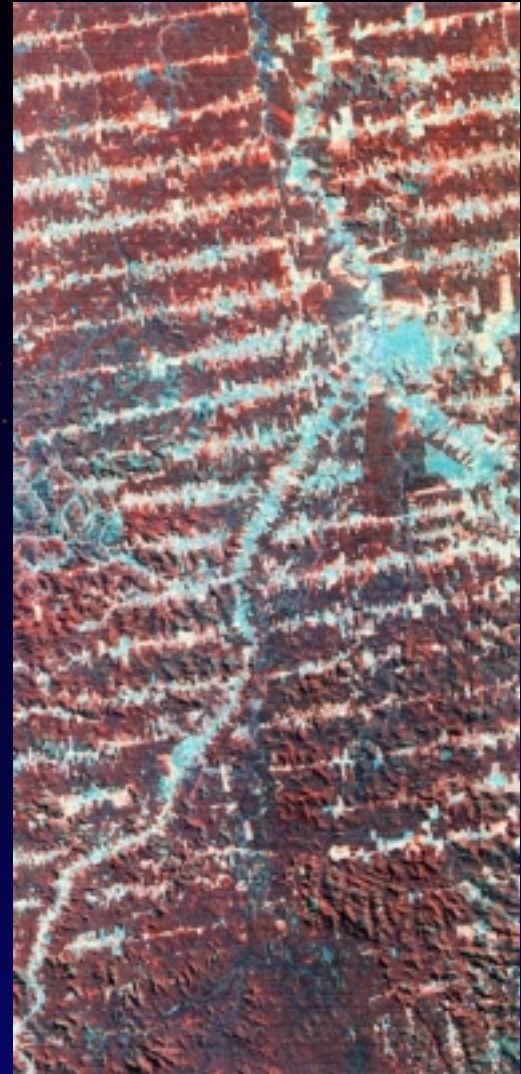
Deforestation: Rondonia, Brazil



June 19, 1975



August 1, 1986



June 22, 1992

Water Resources: Aral Sea



May 29, 1973



August 19, 1987

Water Resources: Lake Turkana, Kenya



February 1, 1973

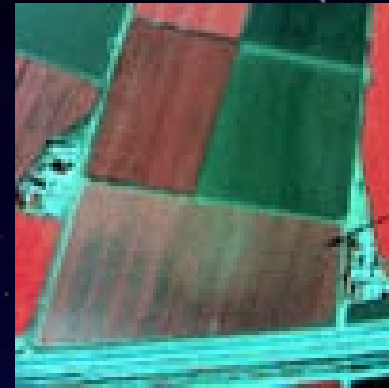


January 12, 1989

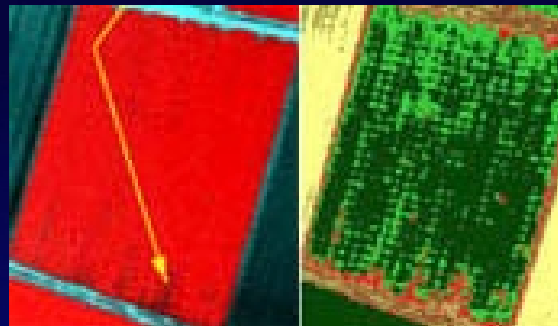
IKONOS Data in Agriculture



Crop Disease



Irrigation



Mildew Detection

IKONOS Applications - Local Government



Developed and
Undeveloped Parcels



Long Term
Comprehensive Planning



Tax Map Updates

Disaster Management by IKONOS

Real Estate Applications



Multiple Listing Service
for Residential Property



Tornado Damage Assessment

Conclusions

- Remote Sensing technology can be used in a wide range of applications.
- New satellites and sensors will provide higher resolution imagery for detailed studies.
- Increased computing power allows us to efficiently process, store, and analyze new image products.
- The future is bright for Remote Sensing.